NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

DATA COMMUNICATIONS
INFORMATION RESOURCE MANAGEMENT
AND NAVAL DATA AUTOMATION COMMAND

by

James L. Branson
and
Thomas H. Yee

September 1984

Thesis Advisor: Carl R. Jones

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Data communications, as in emerging technologies, poses managerial problems for the Navy. The problems involve keeping knowledgable about new technologies, evaluating their application, and controlling usage to ensure compatability with organizational strategic goals. An IRM framework is utilized to examine the problems and to discuss the viewpoints of and decision problems faced by the user, as a buyer, and central management, as the provider (Cont)

ABSTRACT (Continued)

of information based services. Alternative means of providing the service include outside consultants, NAVTELCOM, NAVDAC/NARDACs or expanding an individual activities staff. Each of these is a viable option and each is analyzed. The authors recommend the formation of a steering committee, comprised of representatives from NAVDAC and NAVTELCOM, to provide strategic direction and policy and an organizational Technology Team to provide targeted assistance as a significant step toward managing the implementation of this emerging data communications technology.

Data Communications
Information Resource Management
and Naval Data Automation Command

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ABSTRACT

Data communications, as in emerging technologies, poses managerial problems for the Navy. The problems involve keeping knowledgable about new technologies, evaluating their application, and controlling usage to ensure compatability with organizational strategic goals. An IRM framework is utilized to examine the problems and to discuss the viewpoints of and decision problems faced by the user, as a buyer, and central management, as the provider of information based services. Alternative means of providing the service include outside consultants, NAVTELCOM, NAVDAC/NARDACs or expanding an individual activities staff. Each of these is a viable option and each are analyzed. The authors recommend the formation of a steering committee, comprised of representatives from NAVDAC and NAVTELCOM, to provide strategic direction and policy and an Organizational Technology Team to provide targeted assistance as a significant step toward managing the implementation of this emerging data communications technology.

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A. GENERAL

With the rapidly growing recognition that information is a resource, increasing emphasis has been placed on its proper management. As the technical expert in matters relating to Automated Data Processing (ADP), the Naval Data Automation Command (NAVDAC) and its regionalized satellites play an important role in Information Resource Management (IRM). With the proliferation of office automation equipment, the principal focus has been to tie together the various computers both within an office and between offices via some form of communications. Consequently, another "player", Naval Telecommunications Command (NAVTELCOM) becomes involved. Although the interdependency between ADP and telecommunications is evident from a functional standpoint, the two principals seem to lack a coordinated effort to resolve some of the key management issues resulting from the converging technologies.

The ADP environment is governed by Life Cycle Management (LCM). LCM embraces the strengthening of early decisions which shape the costs and utility of an Automated Information System (AIS). These early decisions encompass full consideration of functional, ADP, and <u>telecommunications</u> requirements to produce an effective AIS. Further, the LCM process seeks to achieve certain objectives including:

1. to assure management accountability for the success or failure of AIS developments and to identify the role and responsibility of functional, telecommunications, and ADP managers throughout the life cycle of an AIS;

2. to establish a control mechanism to assure that an AIS is developed, evaluated, and operated in an effective manner at the lowest total overall cost;
3. to provide visibility for all resource requirements of an AIS; and
4. to promote cost effective standardization of an AIS for use throughout the Department of Defense (DOD) and the Department of the Navy (DON). [Ref. 1: pp. 35 - 55]

Within the context of Navy Industrial Funding (NIF), NAVDAC's organization is placed fundamentally in a "seller-buyer" relationship with its clients. As a "business enterprise," NAVDAC must therefore be responsive to the most current needs of its customers. With this knowledge, the issue reduces to one of selecting the "right" services in the right amount to provide to regionalized customers. As might be expected, there are many complications which exacerbate the development of a simple and straightforward solution including:

1. NIF requirements for stabilized rates;
2. how to forecast or predict customer requirements so as to keep pace with technology and demand;
3. at what level should internal management control be implemented;
4. the differences in the management environments of the two principals with respect to policies, procedures, etc.; and
5. the attendant impact on the level of services.

Telecommunications requirements in support of ADP are submitted by the requiring activity or submitting authority. There are several differences between ADP and telecommunications support regarding to policy, levels of requirements, dollar/approval thresholds, procedures/schedules for submitting plans, submitting authority, validation authority, and

approval authority. A good explanation of these variances and a comparison of the differences is contained in LT A. Sheedy's thesis on the Acquisition Of Telecommunications In The Navy From An Automatic Data Processing (ADP) Point Of View [Ref. 1].

B. OBJECT OF RESEARCH AND RESEARCH QUESTIONS

The purpose of this research is to review and evaluate the role of NAVDAC and its satellites in providing technical advice and support for data communications from the standpoint of Information Resource Management. Inasmuch as IRM entails a wide range of applications, this research will provide only a broad overview of IRM within the context of NAVDAC's role as technical expert on ADP matters. The primary focus will be on who should provide long haul data communications service to its Navy customers and through what means. If pertinent, the research will also address how and where the Navy Regionalized Data Centers (NARDACs) and the Navy Automated Data Facilities (NAVDAFs) as the representatives of NAVDAC should provide data communications services to its local customers. These are the principal research questions as well. The study also seeks to find the answers to related questions such as: "Is NAVDAC the appropriate instrument for effecting telecommunications for ADP?"; "What services/support is needed or desired by Navy customers?"; "Should NARDACs supply complete ("cradle to grave") support for users or merely technical assistance as requested?"

C. METHODOLOGY

Fundamentally, the methodology employed will be to develop a framework of thinking for NAVDAC to deal with essential decision problems. This framework will employ the

IRM concept and will seek to provide insight into various decision problems in a continually changing and turbulent environment within the unique constraints imposed by Navy and DOD policies. In particular, decision problems of interest pertain to what services NAVDAC should provide and how it should provide them. In order to permit a meaningful study, primary emphasis will be placed on data communication services.

D. ORGANIZATION

The organization of this thesis reflects the authors' view of the factors essential to formulating meaningful conclusions and useful recommendations regarding the role NAVDAC must assume in the data communications arena. Because the thesis revolves around economic IRM concepts, a generic framework for IRM is first developed. To establish that the relationship of NAVDAC and its satellites to customers is fundamentally no different than that which exists between businesses in the private sector and information systems suppliers, Chapter III provides a background of NAVDAC/NARDACs within the NIF environment. In a general sense, Chapter IV outlines why computers are linked, what the linked computers can offer, and how to link computers together. Chapter V then provides the scope of the ADP/data communications issue and includes a discussion of data communications costs. Further, the internal procedures within the Navy for acquiring the needed services are outlined. In Chapter VI the essential ADP/data communications management issues are presented. Chapter VII then provides an analysis of the issues presented to that point and offers recommendations. The final chapter summarizes and concludes the thesis.

II. GENERIC IRM FRAMEWORK DEVELOPMENT

A. INTRODUCTION

One indication of the trend towards Information Resource Management (IRM) can be found in the recently promulgated Department of Defense Instruction DOD INST 7740.1 dated 20 June 1983. The instruction sets forth the Defense Department's position in regards to the IRM program. In the instruction IRM is defined as:

> The policy, action, or procedure concerning information (both automated and non-automated) that management establishes to serve the overall current and future needs of the organization. IRM policy and procedures would address such areas as availability, timeliness, accuracy, integrity, privacy, security, auditability, ownership, use, and cost-effectiveness of information.

Although the DOD definition of IRM appears to be somewhat vague, general, or a "pie in the sky" description, the authors will not attempt to defend or argue over its applicability. Rather, a different approach will be employed. To make the IRM framework development more meaningful and easier to understand, the generic IRM system will be described intentionally at a low organizational level. The notions of transfer pricing; incentives, rewards, and penalties; and other management control ideas described in the following sections are equally as applicable at a higher or organization-wide level.

The first section will seek to frame the IRM system in a very general way by describing the IRM system within an organizational entity. Notions of profit are scattered throughout this section but the ideas can be applied to non-profit activities by comparing profit incentives with

cost-avoidance ones. Inasmuch as the procedures for "thinking through" various decision problems from the supplier side are very similar in nature, the next section focuses only on the capacity choice decision problem. Throughout this section the reader must keep in mind that other decision problems (e.g., product mix) can be thought out in a very similar fashion. The final section concentrates on the user or customer side and provides some insight into the user's perspective in seeking services from suppliers. Caution must be interjected at this point since the following sections are founded on and heavily influenced by economic theories. Readers with marginal understanding of microeconomic concepts may wish to first review this subject as this chapter was written under the assumption that readers would have this fundamental knowledge.

B. HOW TO THINK ABOUT AN IRM SYSTEM

Fundamental to thinking about an IRM system is an understanding of

1. its organizational structure and the associated structure of incentives, rewards, and penalties;
2. its decentralized planning, coordination, and control process;
3. the decisionmaking behavior of each of the system components with regard to such issues as capacity, technology, and product mix; and
4. the Central Management's unique role as system manager and coordinator with the organization's other activities so as to decide how much information is enough.

Viewed as an interrelated set of system components managed by a system management procedure, an IRM system can be illustrated by assuming a routinized organization. Its

structure, the principal decision problems confronting individual system components, the basic incentive, reward, and penalty structure for system components, and the vertical flow of data are all graphically displayed in Figure 2.1 Moreover, the organization's interface with external markets is depicted. The separate system components are organizational entities responsible for specified function(s) which contribute to the entire system. The set of incentives, rewards, and penalties along with communication channels between the components and Central Management (as well as among the system components, though not depicted in the figure) and Central Management's controls, combine to make up the system management procedure.

The procedure implied in Figure 2.1 is a decentralized one. Each manager/user is sent communications relevant only to the user's particular component and is allowed to employ local management discretion to attain efficiency and effectiveness within the manager's sphere of responsibility. Reciprocally, messages concerning the details of the specific technologies employed or the input markets local to a system component are not required by Central Management. Most significantly, Central Management strives to attain a level of equilibrium (between information supply and demand). By selecting a combination of transfer price, product, and budget level, Central Management can manipulate the behavior of the individual components in the aggregrate, i.e., the systemic behavior. As each individual manager formulates and solves his respective decision problem, Central Management may select a new combination of inputs to the system components with the goal of progressing to an equilibrium point. In short, this is an iterative process.

Figures 2.2 to 2.4 together with Figure 2.1 will provide keener insight into the decisionmaking behavior of the individual system components. In the most general sense, the

manager of each organizational entity responds to certain stimuli from both inside and outside the organization, in order to satisfy the decision problem based on the most currently available data. In many instances, the component manager has no control or influence on parameters which affect the decision problem itself. As a specific example, the manager of the Software Development and Maintenance unit, a cost center, is confronted with a technology and software product constrained minimize life cycle cost decision problem. The decision variables are the levels for each input and mix of the inputs. In essence, it is the production planning of capacity and technology. Transfer prices set by Central Management and market price of labor are outside the component manager's sphere of control. Therefore, the software manager selects technology and capacity so as to minimize life cycle production costs. In like fashion, the managers of the other organizational units behave according to their applicable set of parameters and inputs in their respective decisionmaking process.

Figure 2.5 provides in graphic form the role of Central Management as the system manager. Central Management's subjective choice of transfer prices, software products requirements and schedule, and user's information budget, is precipitated by the demand and supply for each product, computer service or computer capacity. Most uniquely, Central Management also provides qualitative guidance on the direction of the organization, a vision of where the organization is headed in the future, as well as subjective evaluation of system component managers. Ultimately, Central Management's subjective preference of a specific combination of transfer prices, budgets, and software products serve to resolve the issue of "how much information is worth the overall cost to us." [Ref. 2]

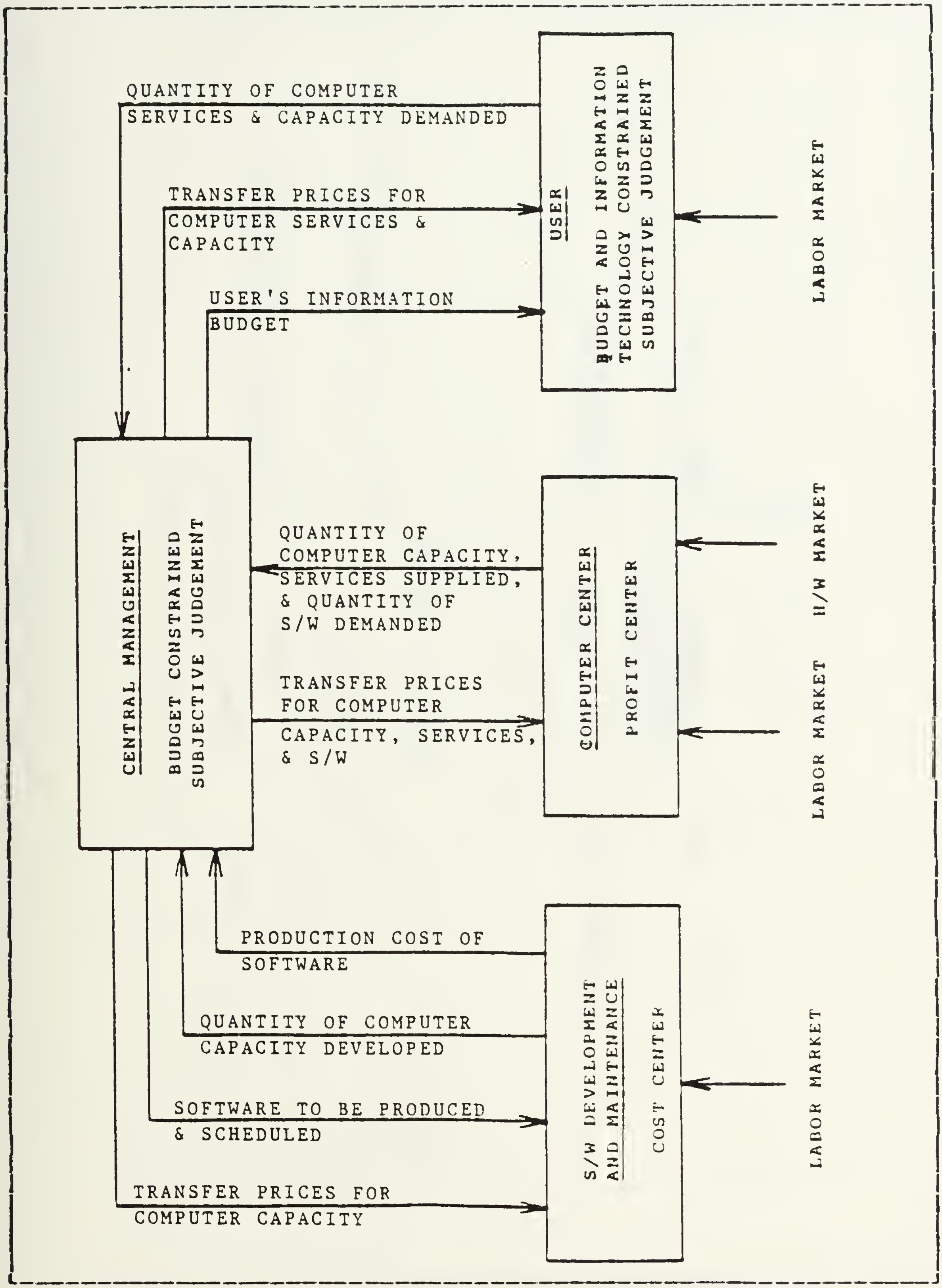

Figure 2.1 IRM Structure.

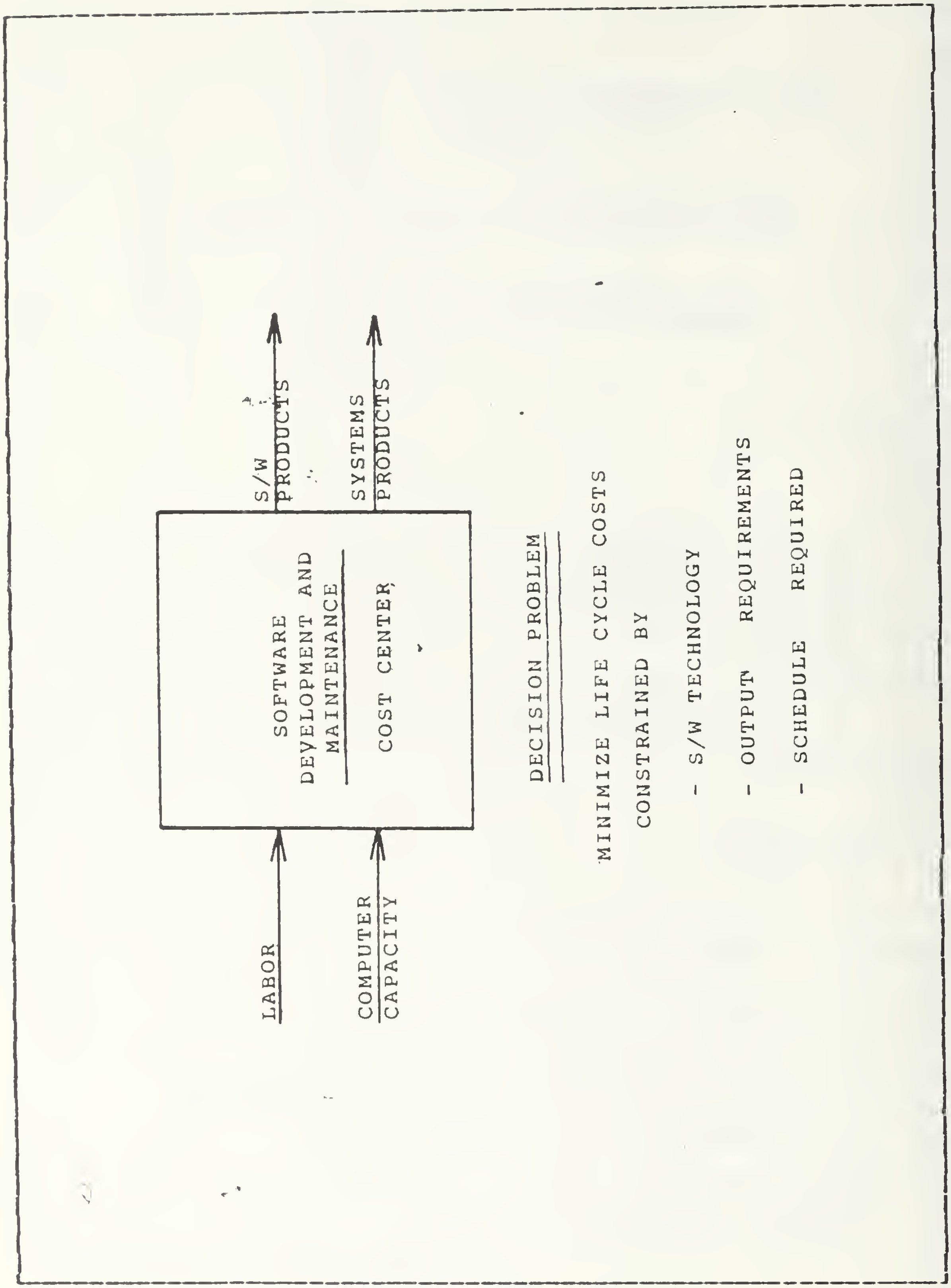

Figure 2.2 Software Development and Maintenance Flow.

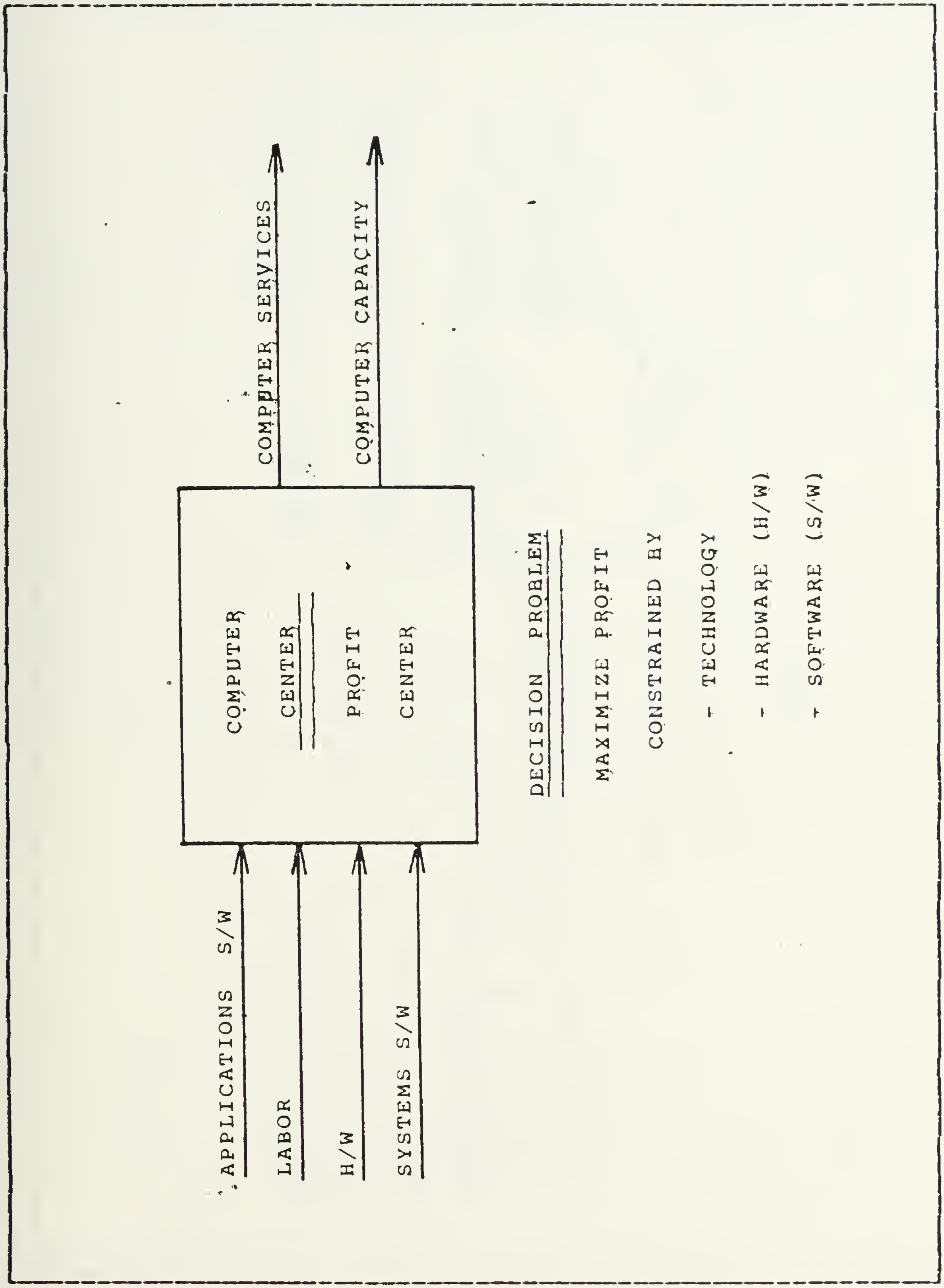

Figure 2.3 Computer Center Flow.

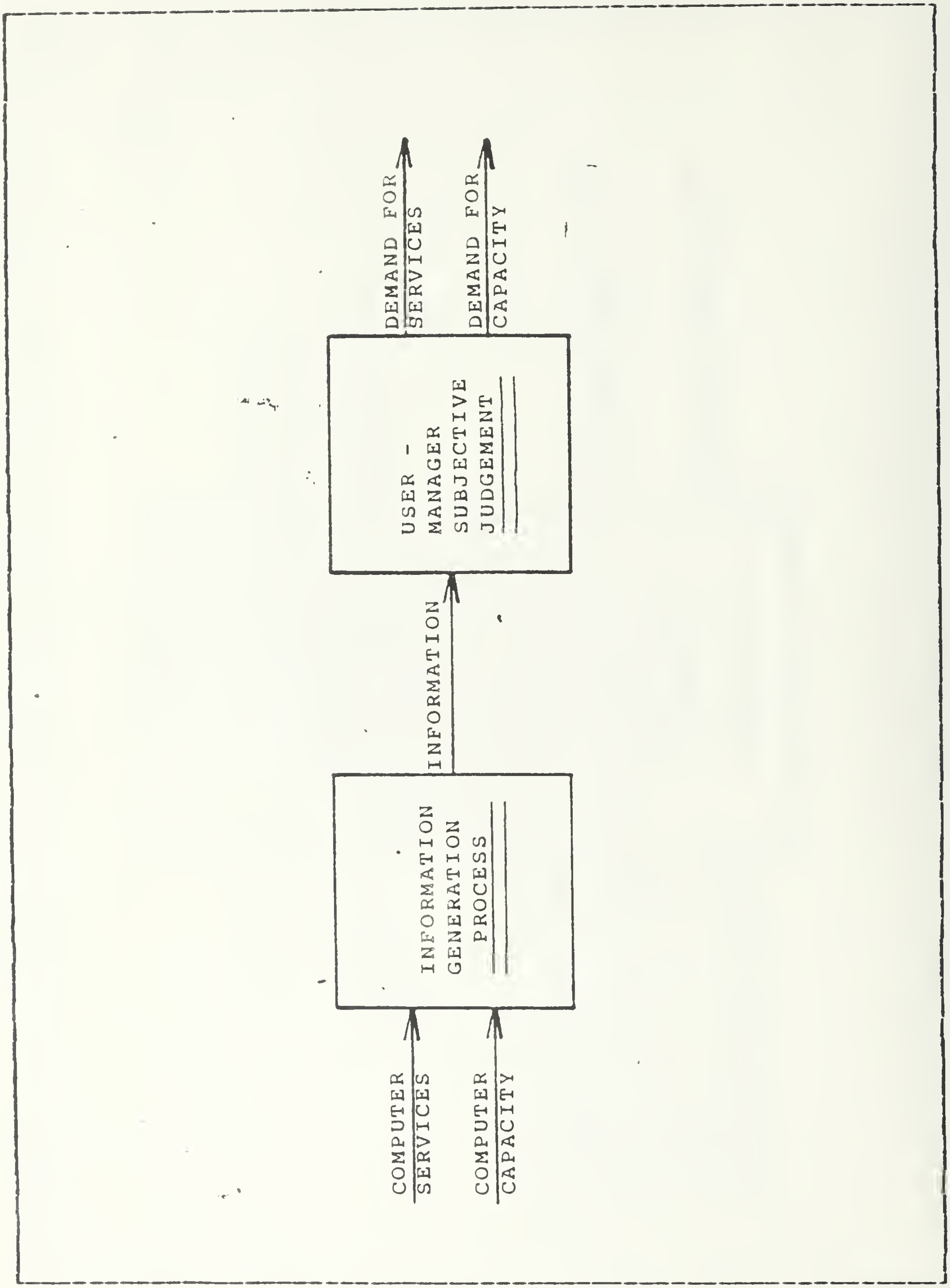

Figure 2.4 Information Flow.

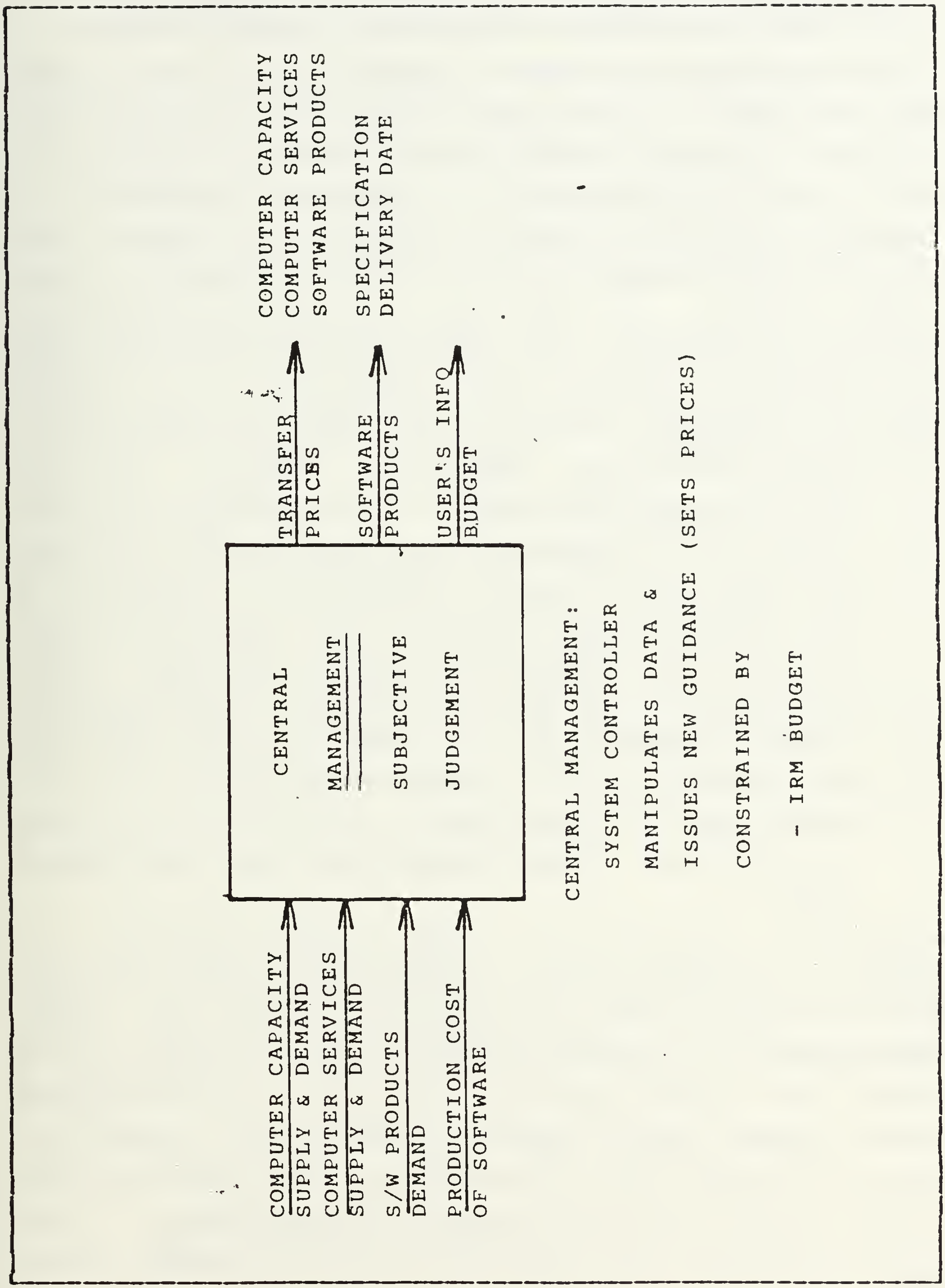

Figure 2.5 Central Management Role.

C. HOW TO FRAME THE CAPACITY CHOICE PROBLEM AND SEARCH FOR ITS SOLUTION GIVEN THE STRUCTURE OF A PROFIT CENTER

To facilitate the reader's understanding of the capacity choice problem, it is necessary to abstract to a level above the system component level and view the IRM System as a single entity with resources as inputs and information as outputs. Applying the concept of incentives, rewards, and penalties, this single entity can be structured as a profit center. Further, the technology available for creating, storing, and providing information provides the relationships between resources and information. To further simplify the scenario, the following asssumptions are made:

1. Pure and perfect competition exists - pure and perfect competition occurs when the market is in such a state as to render the individual actions of either the buyer or the seller insignificant in relation to the overall market. Further, the underlying assumption is that complete information regarding market prices and quantities are available to all concerned.
2. Future resource prices and transfer prices for information are identical to current prices.
3. Decisionmaking focuses only on scale - one input (or resource usage need) yields one output (or product need).

Accordingly, the choice of a maximum profit production plan reduces to the consideration of possible alternative general characteristics of technology related to scale with further examination of the profit maximizing scale of operations. In reality, the profit maximizing decision includes capacity choice, as well as the choice of resource mix, technology choice, and product mix. Specifically, the interrelatedness of these issues requires resolution concurrently. For the sake of simplicity, the focus will be on the capacity choice alone.

Fundamentally, the emphasis is placed on technology and how it can generate the desired information. With this in mind, there are four steps in exploring technology characteristics. In order from simplest to most complex, they are:

1. constant returns to a variable input;
2. decreasing returns to a variable resource;
3. increasing returns to a variable resource; and
4. stages of production which incorporate steps (2) and (3).

Returning to the central issue, i.e., the profit maximizing capacity, it is apparent that the profit function must be incorporated in some way. Before proceeding further, however, it would be fruitful to briefly discuss the concepts of discounting or present valuation. With the knowledge that interest rates (opportunity to earn additional money) and inflation rates affect the real value of money over time, managerial decisionmaking must take into account the value of time. Accordingly, discount factors (or interest rates depending on the perspective) are applied to calculate this time value. Without entering into a detailed discussion, the present value, Pv, of a single amount, F, payable in lump sum, n years from now and assuming an interest rate of r, can be computed as follows:

Pv = F/(1+r)**n

With this basic understanding of the concept of discount factors for present life valuation, and omitting the mathematical derivation, the decision problem can be stated algebraically as

MAX {Sum (t=0,T) (1/(1+r)**t)} * (q*I - Pr*R)
by choice of I, R
constrained by I = I(R)
I,R ≥ 0

where

t = any period of time from 0 to T

T = organization planning horizon

r = discount factor (cost of capital)

q = transfer price of information

I = information

PR = market price of the resource

R = resource

By rearranging this equation, profit can be measured in units of information (i.e., divide by life cycle costs of information) and an economic tradeoff of resource and information is also generated (slope). Because of the assumption treating future prices identical to current prices, discounting aspects cancel out and maximizing profit in the present will account for the maximum profit in each of the succeeding planning years and over the life cycle. Recognizing the new equation is of the form $Y = b + aX$, isoprofit lines can be plotted on the same graph as the Total Productivity Curve (TPC). The slope of the isoprofit line is, again, the external economic tradeoff. The profit maximizing production plan occurs when Marginal Physical Productivity (MPP) equals the resource/information relative price. Graphically, this is the slope of the isoprofit lines. This occurs in the decreasing returns stage. In effect, this process can be described as matching the organization to the environment. Conceptually, the path represented by the TPC is "transited" with various stops along the way to check the value of the tradeoffs. If a higher rate can be achieved internally, (as opposed to externally) then continue to conceptually transit the TPC path until internal tradeoffs match the external tradeoffs (or it is passed, then back up). Of course, there exist other orientations to reaching this profit maximizing point. From the

"input view", the operative question is "how much more information will be generated by an additional unit of input?" Stated another way, "is incremental revenue greater than incremental cost?" If so, proceed along the conceptual path (TPC) until Marginal Revenue equals Marginal Cost. The "output orientation" considers cost. Again proceed along the TPC as long as incremental costs are less than the incremental revenue until the Marginal Profit equals zero, i.e. Marginal Revenue minus Marginal Cost equals zero. Irrespective of the method of search, the same point is reached.

A compelling argument can be made for employing what is known as the Manager's Cost Function. This relates the cost of producing information to the quantity of information produced. Employing this perspective yields the minimum cost to produce a given level of output. A decision based on the Cost Function implies a choice of technology since it is shaped by technology and the resource price. The concepts of Marginal, Average and Total Costs can be applied to evaluating the Cost Function. A word of caution must be interjected here since costs are meaningful only in the context of the decision problem. In other words, what is fixed in one decision problem may be variable in another. With fixed costs, Marginal Cost remains unaffected but the Average Cost Curve is raised at every output level. Employing the Cost Function in searching for the optimum level of output entails finding the point on the Cost curve where Marginal Profit is zero.

In summary, there are various methods available for seeking the solution to the capacity choice problem. In general, the methods utilize incremental values, other things being equal. Whichever method is selected, the results will be identical.

D. USERS' PERSPECTIVE OF IRM

1. Aspects of Cost

The requestor (also referred to as the user in this section) must examine the cost versus the benefits of the service or product being considered. In most cases the total benefit to be derived and the total cost to obtain the benefit are a combination of the obvious and the not so obvious. Depending on the service or product, the benefits may be quantifiable or more qualitative in nature. They could be measured in terms of a new machine which produces more units per hour or the benefit may be something harder to quantify such as high morale or better communication between personnel. The cost as well may be easily measurable or more subtle. The cost may be as obvious as a price tag on a machine or more subtle, such as the cost of opportunities forgone.

A simplistic example may illustrate these factors of cost to a requester. A father wants a bicycle for his son. He (the requester) goes to a store (the supplier) to inquire about the price of a boy's bicycle (product/service). The cost he is told is $110. The father at this point is faced with his first decision among three basic alternatives: buy the bicycle from the supplier; build the bicyle himself; or not get the bicycle, as the price seems higher than the prospective benefit. After some reflection he decides that he can build the bicycle himself at less than the price quoted by the supplier. The father prices the piping, chain, sprockets, etc. and finds that the material cost is $60. He therefore decides that the cost ($60) of providing the product himself ("in-house") is (a) less than the cost of aquiring it from the supplier and (b) less than or equal to the benefit (ie. family/emotional well being) to be derived from obtaining the product/service.

But, there are additional costs that must be considered. The father must cut and shape the pipe into the appropriate pieces. Now to purchase the machines to accomplish this would end the project right there as the additional cost would be prohibitive. In this example however, the father finds a business that will do the shaping and cutting - for a price. The father takes his plans and pipe to the company and the deed is done, at a cost of $20. Now he simply returns home, assembles the parts, and he has a bike for a material and shaping cost of $90. Therefore, he has produced a bicycle (product/service) for a cost of $90 (in-house) as compared to the $110 that would have been charged by the supplier.

In the example above the father saved $30, or did he? There are also the cost of opportunities forgone. There are usually two aspects to a person or organization producing a product or service from within - time and money. Each of these areas has its own considerations. There is the simple, countable aspect of the money paid to the provider of the items or services used in the in-house production of a product. Also, as a rule, the amount of money available to an organization is not unlimited. If money is spent on one item or service it is then not available to be spent on a different item or service. In the example of the father, the money spent on the bicycle was no longer available to be spent on another item, a new calculator for instance. Perhaps the father in the example was a tax consultant and the new calculator would have allowed him to provide faster and more reliable service to his clients. This improved capability may have enhanced his ability to hold present clients and to interest potential ones. These customers generate revenues, but since he elected to spend the money on the construction of the bicycle vice the calculator, this potential increased revenue is lost. That

opportunity forgone ($) is really an additional cost of the decision to provide the bicycle in-house.

Time is usually another aspect of cost. If a company either hires or utilizes personnel already in the emplcy of the company to provide a product or service that cost may be calculated as the sum of X$/hr times the hours spent by each employee on providing the product or service. However, that sum may not encompass the total cost. Returning to the example, the father spent an hour going to the supplier to get a price, two hours drawing up his own assembly plans, an hour getting the materials, an hour waiting for the pipe to be cut and shaped and two hours actually assembling the bicycle. Had he decided to purchase the bicycle from the supplier, the majority of that time could have been spent doing tax work which would have generated income. If he normally charges $20/hr for his time, then the additional time spent providing the product in-house has a cost associated with it that can be calculated. That cost of opportunity (revenues) forgone then becomes another factor in the cost of the decision to produce the product in-house.

At this point it is time to add up and compare the cost to the father of obtaining the product (bicycle) from the supplier versus providing it in-house. To purchase from the supplier the cost would have included:

1.	$110	cost of product
2.	+ $20 ($20/hr x 1hr)	cost of time
3.	---------------	
4.	$130	total cost

The cost to obtain the product/service in-house includes:

1.	$60	parts
2.	$20	bending and shaping

3. $160 ($20/hr x 8hrs) cost of time
4. ---------------
5. $240 total cost

So what appeared at first to be a savings of $30 by providing the product in-house was in reality a loss of $110 as compared to purchasing the same product/service from the supplier.

The point of this section is, of course, not whether one should purchase or build a bicycle. The point is that when a company is comparing the benefits of a product or service to the cost of alternative means of obtaining the product/service, many not so obvious factors must be included in the cost calculation.

2. <u>Initial Considerations for a New Service</u>

It seems that there should be a logical process to be followed in making such decisions as obtaining a new service or product or in evaluating current products/services. For a company being offered a new service there is a series of questions or evaluations that would seem pertinent to the decision. First, does the service hold potential benefit for the potential buyer? At first this may seem to be a superflous question. After all, products or services must have a benefit associated with them or they would not be in the market place. The question here, however, is whether the product or service in question provides potential benefits to the specific company and that company's function and goals. The answer must start with a clear understanding at the user and management levels of exactly what those functions and goals are.

If the answer to the question above is yes, then the second question becomes pertinent. "What is the value of the

potential benefit to the company?" This is not an easy question to answer and contains in itself room for considerable evaluation. The strictly numerical benefit is of secondary importance at this point to the question of relative benefit. It is not often that an organization finds itself in a situation of having "spare" money (money that if not spent on the service/product in question would not be put toward other products, services, or in some other manner used to derive a benefit) to spend on a new product or service. In that most unusual case the decision is simply one of determining if the expected benefit is of more value that the monetary cost of obtaining that new product/service. More often it is a question of the value of the benefit of the new service relative to that of products/services on which funds are already being spent. Thus, the decision to spend a portion of the organization's funds or resources should also include a review and ranking of the benefits of those products/services on which funds are already being spent. Once this is accomplished, the expected benefits of the potential product/service can be compared on a relative basis to the present products/services and ranked accordingly. This is an important prerequisite to the next step.

3. The In-house Vs. Buy Decision

Once the decision is made that the potential product/service is of benefit to the particular organization and its benefit relative to present services has been determined, the next aspect to be evaluated is cost. A series of questions is applicable at this point. "Can the potential service be provided by "in-house" expertise?" If the answer is "no" then the cost evaluation becomes one of taking the least cost among competitors who offer equivalent services. If the answer to the question is "yes", then the natural

follow on question is, "At what cost to the organization can the service be provided "in-house"?". This costing out process must then include, as demonstrated by the bicycle example, both "direct" and the "substitute" cost. The direct cost in this case is the cost of any new material required plus the salary of individuals assigned to providing the service. The substitute costs are the costs of lost benefits/revenues that they would normally be producing if they were still assigned to their normal endeavors.

There may be room for some argument as to whether or not the salaries of those people assigned should be included in the cost of providing the new service since the organization was already paying them. The fact that they were paid previously and would still be paid to perform their normal functions had they not been assigned to provide the new service really pertains to the cost of providing that previous service. Once their efforts are applied to providing the new service then the cost of their salaries becomes a part of the total cost of providing that new service.

Once the cost of producing the new service "in-house" has been determined, the cost of "in-house" versus market cost can be compared and a least cost to the organization of obtaining the new service can be determined.

4. Deletion vs. Reduction Methods of Expenditure Adjustment

At this point the organization knows the cost of the potential service and its benefit value relative to other services for which funds are being expended. It can also be assumed known what total revenue is available to be expended or in a phrase the "budget constraint". In general the cost of services to be considered here fall into one of two categories - analysis cost or systems cost. Analysis cost

is the cost of a service which is a one time cost and may or may not lead to changes in the organization or its way of doing business. The funds paid to a consulting firm is a good example of analysis cost. The firm is paid to view, define, and analyze one or several aspects of the organization. Their work usually concludes with recommendations for changes. These changes may be organizational (structural or personnel) or tangibles (new machines or the implementation of new technologies involving communications, data processing, etc.). The results of this work may or may not result in action by the organization. But if the recommendations are acted upon the changes will usually involve cost, especially in terms of tangibles, that may be continued for several years to follow. These costs are referred to as systems cost.

The preceding distinction is important to the analysis that follows to the extent that, although to do either requires that something must be given up (if our budget constraint remains constant), the expected duration of the new cost may have an effect on the decision of what to give up. The point should be made that if the expected benefit of the new service is of low relative ranking to the benefits offered by those services for which the organization is already expending funds the decision may be made to give up nothing and forgo the expected benefits of the new service and the process stops. In the case where the relative benefit is high enough to make it desirable, the user is faced with the decision of what to give up. Here again there are options. The user can simply list all the services and their associated cost (including the potential service) in the order of the determined value of their associated benefits. Then starting with the most valued work down the list until a level matching the maximum expenditure level allowed by the budget constraint is reached. At that point

the user draws a line and gives up, for a period of time (determined by the class of service - analysis or system), those services which fall below the line representing the expenditure level. This method may be referred to as the deletion method. Many times however, to follow the above method is not practical as it would, among other things, indicate that the need for those services discarded was questionable to start with. A more plausible approach might be to adjust the levels of some designated services and thus combining reductions in cost enable the organization to retain the services while at the same time meeting the level of total expenditures defined by the prescribed budget constraint. This is referred to as the reduction method of expenditure reduction and is described in the next section.

This thesis will confine itself to the question of the possible expenditure for an analysis service, which therefore requires a relatively short term adjustment to expenditures to fund the cost of the analysis. Also it is assumed that after some managerial consideration it was determined that the reduction method of expenditure adjustment was deemed the most desirable method of releasing revenues to fund the analysis service. Further, to simplify somewhat the analysis of the problem, it is assumed that management has narrowed down the area to be reduced to one or a combination of two present services. This reduction is to be considered to be needed for the period in which the analysis cost is incurred, one year. This eliminates the need for adjusting for the value of money over time, which can be added to the analysis of the longer term system's cost decision problem.

a. The Reduction Method Analysis

The first criteria to be met in this problem is that the combined expenditures (E) for those two services

designated by management for reduction must not exceed that portion of the budget allocated to them (B). That is:

$$E \leq B \tag{2.1}$$

The expenditure for the first service can be defined as the cost of that service per unit (p1) times the number of units (S1) of that service desired. Thus for the first service the expenditure can be given by:

$$p1S1 \tag{2.2}$$

The same logic is followed for the second service (S2) and its unit price (p2). The combined expenditures then can be presented as:

$$E = p1S1 + p2S2 \tag{2.3}$$

As discussed previously the combined expenditures must not exceed some predetermined budget constraint. Thus,

$$E = p1S1 + p2S2 \leq B \tag{2.4}$$

Foregoing the budget consraint for the moment, there are an infinite number of possible combinations of S1 and S2. Some combinations may be preferred by management over others. However, there are other combinations for which management is equally satisfied. In other words, one combination of services could be substituted for the other. These combinations of services, for which user management is equally satisfied, can be plotted and joined by a line to display a geometric representation of this relationship. Referring to

Figure 2.6, curves 1, 2, 3 and 4 are representative of such curves where combinations (points A and B on curve 3 for example) of services along the same curve are substitutable for each other.

Because of the infinite combination of possibilities that exist there can be an infinite number of these substitution curves. At this point it may be beneficial to summarize some points: 1) there exist an infinite number of combinations of services 2) some of which can be evaluated by the user as being equally desirable and 3) these families of combinations (substitution curves) can be ordered in terms of relative desirability.

Logic would tell one that the user would prefer that substitution curve which gave most of both services and the user would therefore choose any combination of services on say curve 4 over any combination found on curve 2 (It should be noted that it is not to be inferred that those combinations on curve 4 are neccessarily twice as desirable as those on curve 2). The user's choice is really confined by only two factors - the technological feasibility of the combinations and the self-imposed expenditure limit as defined by the budget constraint.

Analytically the substitution curves can be described by the slope between any two points on the curve. The slope can further be described as the change in the quantity of service two (S2) relative to the change in quantity of service one (S1). Because of the orientation of the axis in Figure 2.6 the negative slope must be taken in order to result in a positive numerical figure. Symbolically the relationship would be:

This change can also be thought of as a marginal change in the level of one service as compared to the change in the level of another service, both of which are on the same substitution curve. For reference purposes the slope

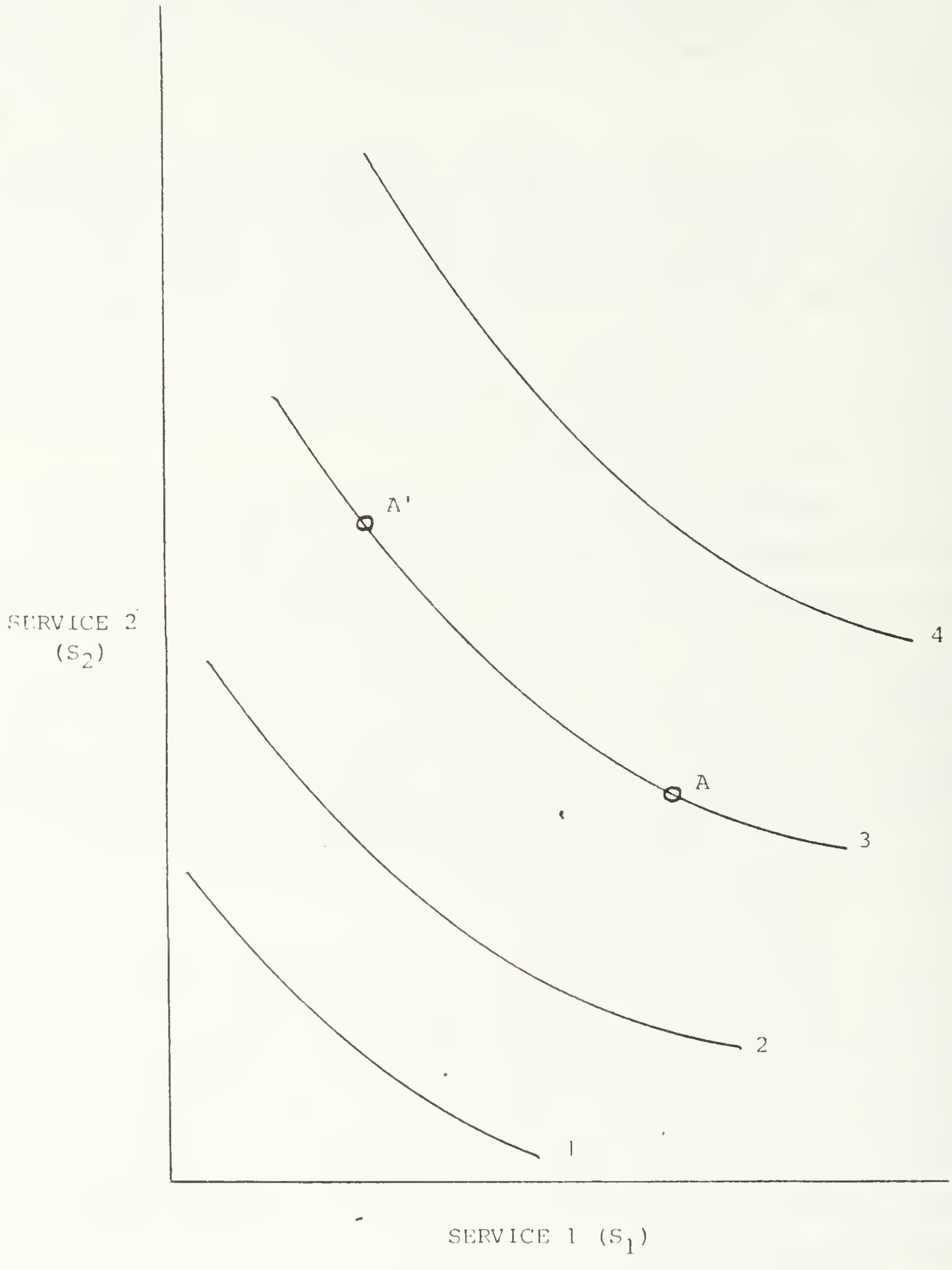

Figure 2.6 Substitution Curves.

$$dS2/dS1 = \text{slope} < 0 \tag{2.5}$$

will be called the Marginal Rate of Substitution, MRS(S1,S2). Thus it can be said that:

$$MRS(S1,S2) = -dS2/dS1 \tag{2.6}$$

The budget constraint can also be represented geometrically. The budget constraint is a line, the slope of which is defined as the ratio of the marginal cost of service one (p1S1) as compared to the marginal cost of service two (p2S2). Thus the budget constraint (B) can be represented by a line with slope:

$$p1S1/p2S2 \tag{2.7}$$

Utilizing these concepts it can be seen that for a given substitution curve, the optimum mix of S1 and S2 is where the prescribed budget constraint line just touches (is tangent to) a given substitution curve. This tangent point is defined mathematically as where the slopes of the two lines are equal. Thus, where:

$$-dS2/dS1 = -p1S1/p2S2 \tag{2.8}$$

Graphically this can be represented by displaying both the substitution curves and the possible budget constraint lines on the same graph. The relationship is displayed in Figure 2.7. Obviously which substitution curve/budget line combination to use is determined by the level of the budget constraint or graphically by its distance from the origin. [Ref. 2]

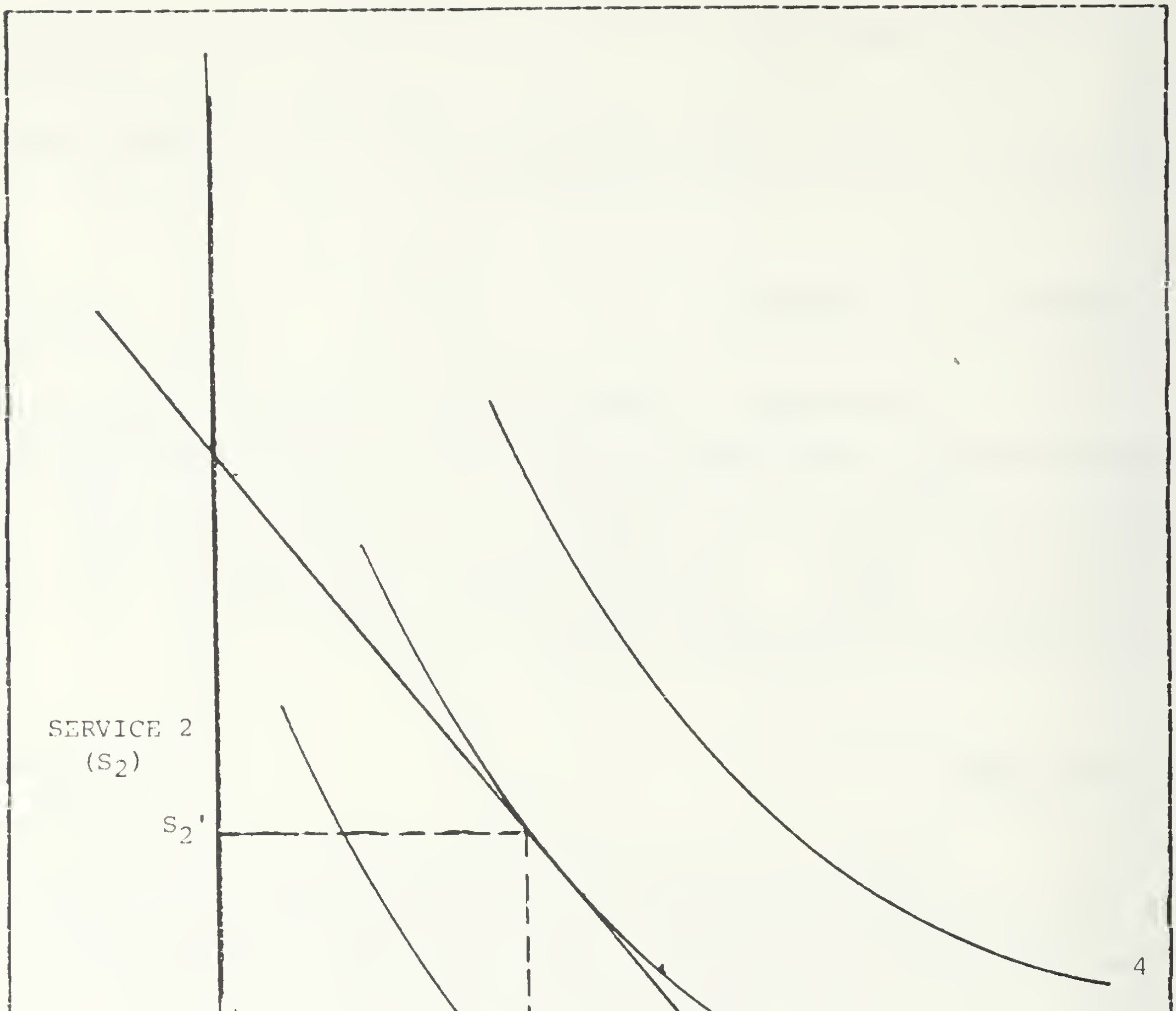

Figure 2.7 Optimum Mix of Services.

5. Valuation of Potential Benefits

Touched upon earlier in this chapter was the idea that benefits, both of the present services and the potential benefits of the prospective services, should be valued and ranked. Left unanswered was the question of how to value such things. The problem is that there is no iron-clad, one-formula-fits-all answer to the question. What is the value of a service? That depends on the service and to whom the question is directed. Depending upon the user's view, the same service can be valued differently by different users. Taking a hardware example to illustrate, consider two processors - processor A can perform 100 transactions per second (TPS) and processor B can perform 120 TPS. Therefore one might say that, based on TPS capability, processor B is of more value than processor A. But how much more valuable? Is the additional 20 TPS offered by processor B worth $10,000 ? Is it worth $20,000 ? Perhaps only $5,000 is all the additional TPS capability is worth ? The answer could be "yes" to any of the questions. It is dependent upon the prospective user's view of the value of the benefit, in this case, of a capability to process an additional 20 TPS. That user's view is shaped by the particular application, needs, size of the operation, revenue available, etc.

This is particularly true for the valuation of something like an analysis cost. How much is it worth to have an outside expert evaluate one's data communication structure and recommend changes ? Answer: it depends. It depends on the client's perspective of the present condition and the effectiveness of data communications, on the size of data communications costs relative to the companies operating budget, the perceived value of the potential improvements, the value of competing demands on revenue, etc. Thus, the value to be derived from an analysis of costs is in fact

very subjective and must be determined on an individual basis. The question may become, " Given the impact of this area on the total operation of the organization, can the organization afford not to seek or invest in the search for improvements ?".

Hopefully the product of the analysis will be reccommendations for changes that have attached to them quantifiable benefits in terms of increased efficiency, effectiveness or reduced cost. Armed with this information the user is in a position to go through an analysis, such as the one described earlier in this chapter, to evaluate the optimum mix of services/products given a budget level constraint.

6. Case of Two Potential Alternatives

If the analysis results in a decision between two services that cannot be mixed as described earlier, a straight one-or-the-other decision may be made using other decision criteria. For instance, if the analysis offers two alternatives for improving effectiveness (each with its own associated cost), which should the user select? Again different sources offer different solutions to this problem.

One such source is Barry W. Boehm [Ref. 3] who presents several possibilities in regard to software but which could also be applied to the more general cases under discussion here. It should be noted at this point that all three models to be discussed assume that measures have been determined to approximate the relative effectiveness of the services and their cost.

The first mentioned is the Maximum Available Budget method. Referring to Figure 2.8, if the budget constraint is $100,000 then the choice must be alternative A with an effectiveness of 50 units. In many cases this is where the decision falls, a simple matter of the bottom line - money

available. If the effectiveness can be quantified with some high level of confidence and the organization has some flexibility in the budget available to be allocated to the new service, then the additional effectiveness to be realized from say a 10% increase in the budget should be examined. Referring again to Figure 2.8, expending an additional $10,000 (10%) would equate to 75 units of effectiveness, a 50% gain. If, on the other hand, the decision has been made not to spend any funds unless a certain baseline effectiveness can be realized, then the choice is simplified to the least cost alternative which supplies that level of effectiveness. Referring to Figure 2.8, to attain an effectiveness of 75 units alternative A is the obvious choice.

If the organization is interested in acquiring the most "bang for the buck" or effectiveness/dollar spent, an effctiveness/cost ratio can be examined. It is obvious that a line can be drawn along which each point represents the same ratio of effectiveness to cost. Such lines are shown as "X", "Y", and "Z" in Figure 2.9. Given the desire to maximize effectiveness per dollar spent, the choice in the case shown would be where the line representing the highest ratio touches one of the alternative cost lines (point C). This choice seems logically sound and can be used as long as the point selected falls within any budget and minimum requirements constraint which may have been placed upon the decision.

Lastly, another model presented by Boehm is referred to as the Maximum Effectiveness-Cost Difference criteria. It assumes that there is a way to relate cost and effectiveness on the same scale. In other words, one can then measure effectiveness in terms of both effectiveness units and dollar worth. Thus, once a dollar value has been assigned to each effectiveness unit, the alternatives can be evaluated as shown in Figure 2.10. Line "L" represents those points

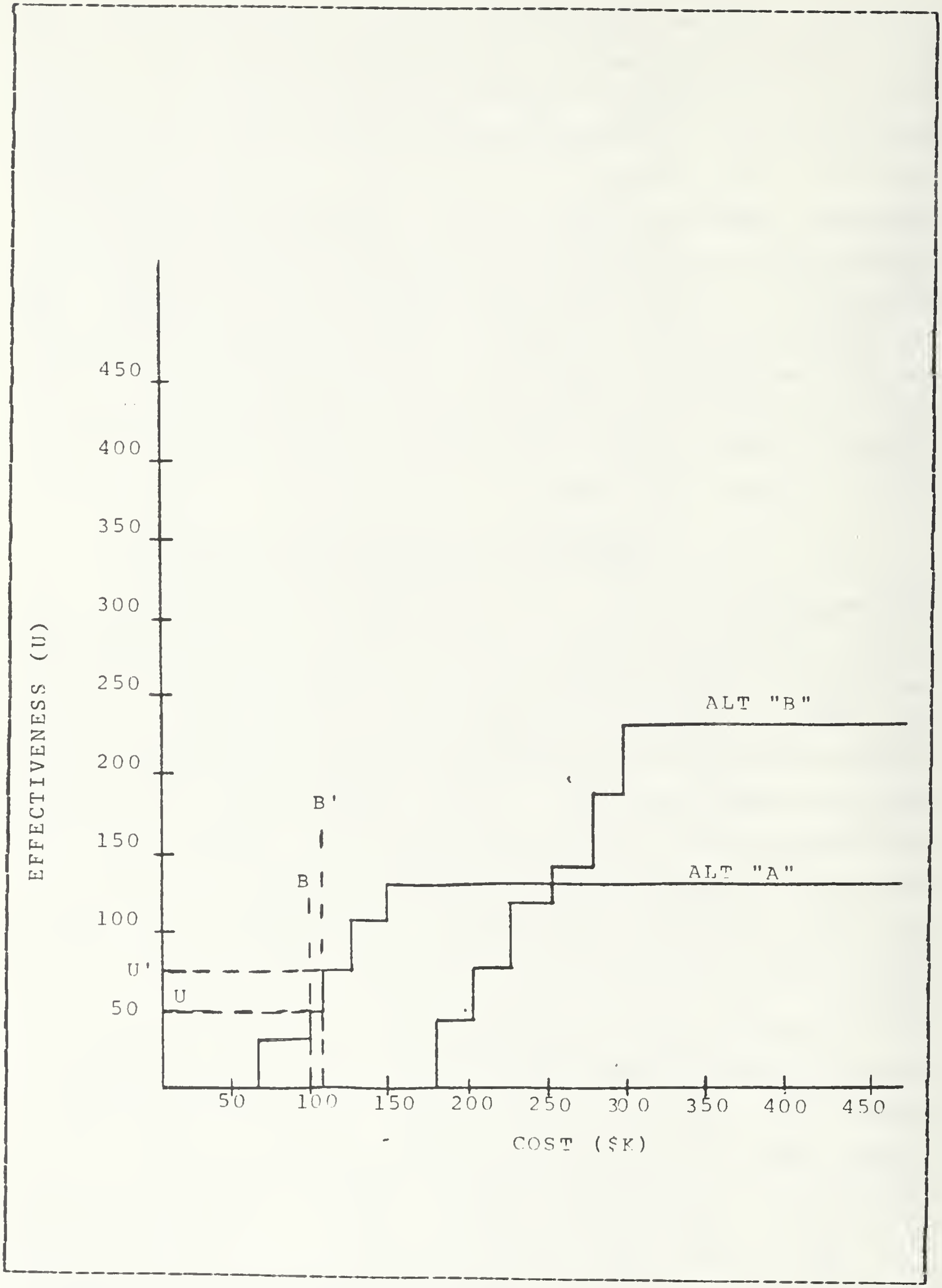

Figure 2.8 Maximum Available Budget Method.

where effectiveness dollar value is equal to the cost in dollars. The point of maximum effectiveness-cost difference then is that point on the alternative's cost curve which is the highest above the line "L". Referring again to Figure 2.10 one could easily calculate the point and the amount which represent the maximum difference between the effectiveness offered by alternative A and the line "L" and conclude that the difference graphically represents $55,000. A similar calculation of the difference in the case of alternative B would conclude an amount of $80,000. As the name implies, one would want to maximize the difference and would therefore select alternative B in this illustration. As before this criteria may result in a solid decision as long as any budget constraint and or minimum effectiveness requirements are observed. [Ref. 3]

7. <u>Conclusions</u>

In summary, the user organization must consider numerous aspects of potential cost and potential benefits when approaching a decision on expending revenues for a new service/product. This section looked at a series of logical steps in the decision process. It started with the obvious, but still often overlooked, question of the pertinence of the potential benefits to the specific user. Also considered were the questions of in-house vs. contracting out, freeing revenue to pay for the new service, and differentiating analysis as a cost from a system or implementation cost. The valuation of potential benefits was dicussed and finally methods for deciding between two potential services, both of which can be measured in some common unit of measurement, were presented.

This chapter has covered a considerable amount of ground and purposely not in the greatest of detail. The point of this chapter however, was not to be the focus of

this thesis, but, rather a background from which to view the actions of potential NAVDAC/NARDAC clients in relation to proposed new services.

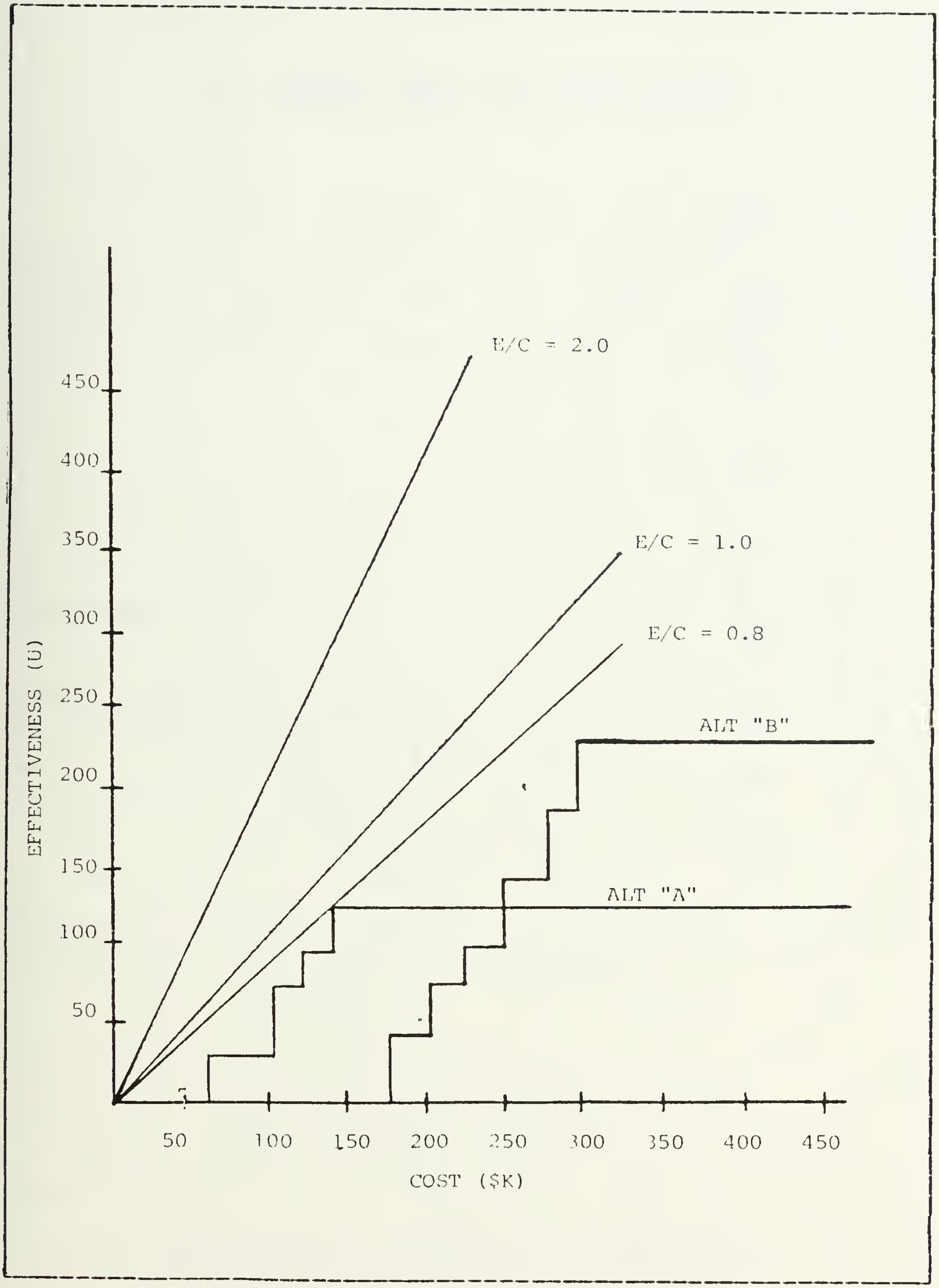

Figure 2.9 Ratio Method.

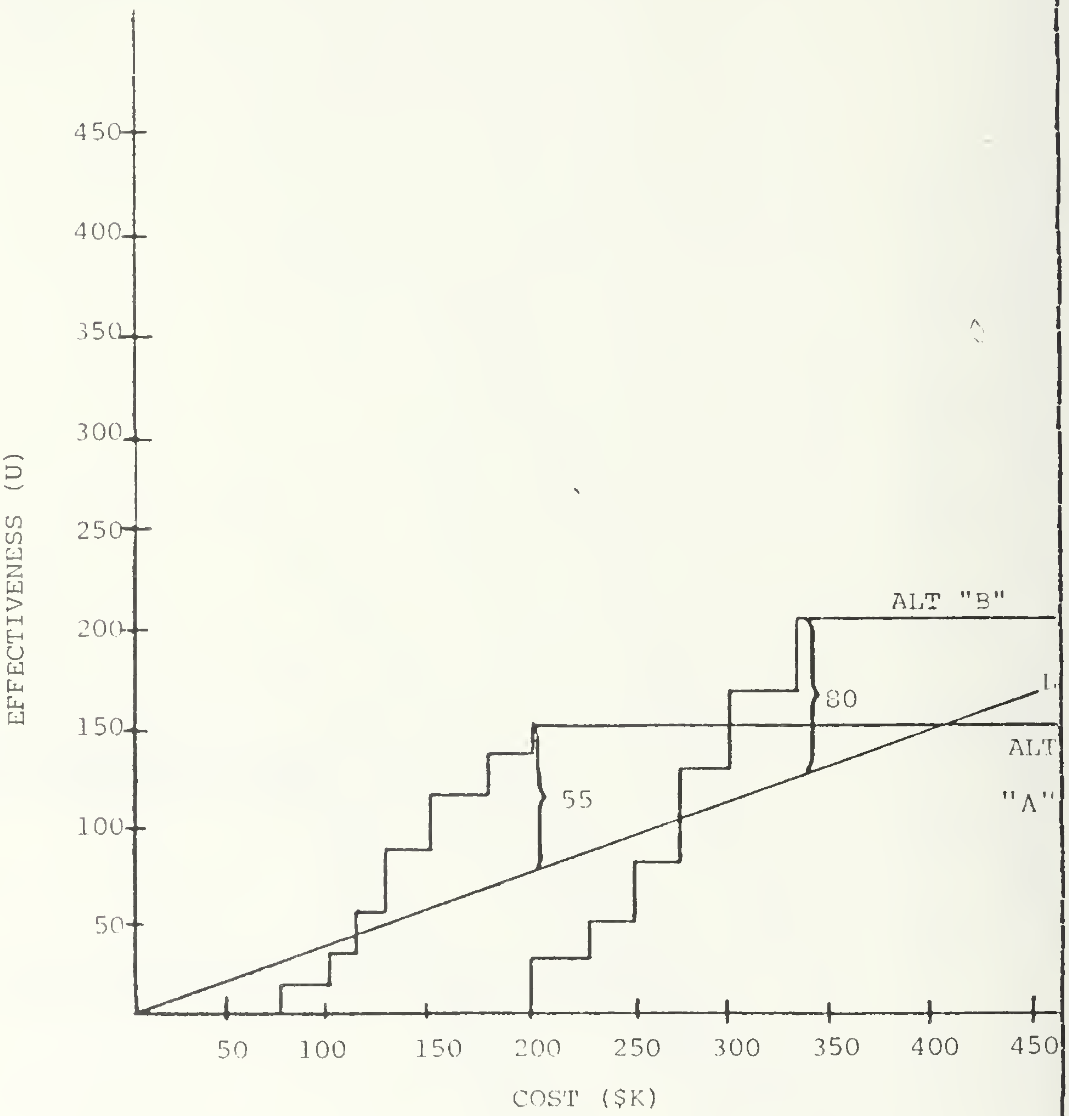

Figure 2.10 Maximum Effectiveness-Cost Difference Method.

III. NARDACS FROM A NIF PERSPECTIVE

A. INTRODUCTION

A 1978 General Accounting Office (GAO) report entitled "Accounting for Automatic Data Processing Costs Needs Improvement" disclosed that many Federal agencies were employing inadequate accounting methods for capturing the relevant costs for Automatic Data Processing (ADP) operations. Cited in the report was the impact of inaccurate costs on both supplier organizations and user organizations. On the one hand, ADP managers providing the services were confronted with the problem of choosing from less than optimum alternatives for equipment replacements or enhancements given the inaccurate cost information. Moreover, the charges for ADP services performed could not be allocated with the degree of accuracy needed to ensure fairness. On the other hand, the managers of user organizations found it nearly impossible to accurately forecast or budget for the implementation and operation of desired services. [Ref. 4] In short, the report argued that the mission funded concept was inappropriate for acceptable accounting in the ADP environment. In response to the GAO report as well as subsequent Congressional studies, the Navy recommended the inclusion of Navy Regional Automated Data Centers (NARDACs) under the Navy Industrial Fund (NIF) concept as part of the Navy input to the Fiscal Year (FY) 1984 Presidential Budget. NARDACs are service centers providing regionalized ADP technical and operational support to client Navy activities to fulfill organic data processing requirements. [Ref. 5]. The thrust of this chapter is to explore the implications of NIF funding as it relates to the operation of NARDAC in its role

as supplier as well as the attendant impact on user organizations. Organized chronologically as much as practicable, this chapter will first present a brief perspective of NARDAC cost accounting prior to the implementation of NIF accounting and will be followed by an overview of industrial funding. Rate stabilization will be discussed next and then the implications of rate stabilization and conversion to strictly reimbursable funding will be examined. Finally, a brief evaluation will be provided on the effectiveness of NIF funding for computer services.

B. NARDAC PRIOR TO NIF

Prior to FY 1984, the Resource Management System (RMS) was employed to budget for, account for, manage, and report the use of Operations and Maintenance, Navy (O&MN) financial resources for NARDAC operations. RMS entailed a single source of funding which provided Commanding Officers some degree of spending discretion in the conduct of normal operations. In contrast to providing funding in the form of numerous allotments with separate ceilings for various specific areas, RMS introduced greater flexibility in consuming financial resources under continually changing priorities and conditions. As in NIF accounting, RMS featured double entry bookkeeping and accrual accounting. RMS accounting also manifested shortcomings when considering the nature of the NARDAC enterprise. The degree of cost accumulation necessary for accurate distribution of overhead costs was unavailable in RMS accounting. Further, the principal use of RMS was to account functionally for the use of appropriations type funding. In the area of performance measurement, RMS provided only performance reports for comparing actual expense information to budgeted expense

data for a particular period. Performance measures for a comparable private activity would be gleaned from statements of operating results and balance sheets for individual cost centers. Data processing costs could not be identified separately since they were only a portion of program costs and costs were tracked by program with disbursements being tracked by appropriation. Finally, ADP services for mission funded requirements were provided to users as a "free" good or service. In other words, users were not charged unless the work (and therefore the costs) was unprogrammed and in such instances, only direct, identifiable, "out of pocket" costs could be billed. RMS did not lend itself to capturing such data for an individual user activity. In an effort to remedy the identified shortcomings as well as to comply with the accounting guidelines provided in the GAO report, a chargeback system was implemented at NARDAC on an informal basis. The chargeback system was expected to permit capturing fair and accurate cost data and to reflect the total cost of operating the service center. To accomplish this, the chargeback system was to include the following characteristics:

1. Equitable - users must be billed only for relevant charges
2. Repeatable - the level of effort, irrespective of system load, personnel workload, etc., must be the driving factor for determining the cost of a particular job. In other words, the cost for the same job under different conditions should be consistent
3. Accurate - user charges must be computed precisely
4. Understandable - the composition of charges must be apparent to the users
5. Auditable - external sources must be able to trace charges back to their origins

6. Cost recovery - all costs of operation must be recovered
7. Stability of charges - charges must be sufficiently stable to permit user planning
8. Promote efficient use of resources - charges should reward efficient users and tax inefficient ones. [Ref. 6]

C. NIF OVERVIEW

In order to assess the implications of NARDACs operating within the NIF environment, it is imperative to gain a thorough understanding of the NIF system. NIF is a working capital fund. "A working capital fund is a revolving fund used as a source of financing for work (or services) that will be paid by the customer after completion of the job. The activity performing the work pays for costs incurred out of its working capital fund during job accomplishment. When the job is complete, the customer is billed and the fund is reimbursed. The goal of a Department of Defense (DOD) working capital fund is to recover all costs and work to a zero profit." [Ref. 7] A revolving fund is inaugurated by an initial funding from Congress called a "corpus." In order to capitalize and finance the NIF activity as an entity, a charter is issued by the Assistant Secretary of Defense (Comptroller).

Customer activities provide reimbursement from appropriated funds. Dollars also flow between NIF and another revolving fund, the Navy Stock Fund (NSF) - in one case in payment for materials consumed by the NIF activity and in the other case in payment for work accomplished for the NSF activity by the NIF activity. In theory, reimbursement would return the corpus of the revolving fund to its previous

level. In practice, however, this seldom occurs. With the advent of "stabilized rates", NIF activities tend to receive reimbursement from clients at a rate slightly different than the actual cost. For this reason, there is usually a profit or loss associated with each transaction. Consequently, at any point in time, there is usually a credit or debit balance in the corpus of the revolving fund.

As with the other revolving fund, NSF, there are occasions when a direct injection of cash is required. This cash augmentation comes from direct appropriation and is provided basically for two reasons. One reason involves expansion. Should a significant expansion of NIF business be anticipated, it would be reasonable to effect a commensurate increase in the corpus to accomodate the expansion. The other reason for increasing the corpus directly through appropriation involves "stabilized" rate changes. Pay raises and other escalating costs can impact the corpus dramatically when the stabilized rates are significantly lower than the actual costs of performing the services. To offset the net effect of such escalating factors, an appropriate increase in the corpus must be provided occasionally (nearly annually) so that the fund can "revolve" as designed. Supplemental appropriations provide the vehicle for this direct injection. [Ref. 8]

The NIF accounting system resembles the typical private enterprise in many respects. Accordingly, both the NIF budgets and the execution reports are in the format of balance sheets, income statements, and selected statistics. Characteristically, the balance sheet contains the three major sections of assets, liabilities, and owner's equity. With minor exceptions in the asset and owner's equity sections, the accounts contained in the major sections are very similar to those in private industry. On the asset side, as of 1981 the book value of all land, equipment, and

other fixed assets were capitalized into the NIF leading eventually to the inclusion of depreciation charges in the stabilized rates. The capitalization of NARDAC computer assets is a crucial factor since there is no consensus on how to treat software and databases. With the exception of work-in-progress, the asset accounts are not atypical of a private concern. The work-in-progress account, a non-cash account, is fundamentally a temporary account for financing the costs of performing the services until the work is completed. At the completion of the work, the asset can be converted to "cash" by way of the billings. In the owner's equity section, the corpus account provides the current balance of the initial funding of the NIF. The net capitalization account provides the offset for the value of the capitalized fixed assets. The accumulated operating results account is somewhat equivalent to the retained earnings in a business enterprise and it reflects the net gain or loss since the inception of the fund. The equity reserves account is the vehicle for driving budget year rates. Increases or decreases in this account can increase or decrease the cash account balance. In actuality, retained earnings is a combination of the accumulated operating results and the equity reserves. The NIF income statement contains three sections: revenue, costs, and operating results. Key to interpretation of the income statement is revenue recognition. There are basically two methods for this. One method is based on project completion while the other is based on work progress. [Ref. 8]

The total cost of operating a NIF activity can be developed from the three major categories of direct labor/ materials, production overhead, and general and administrative overhead. To recoup these costs three methods can be employed in charging customers. The reimbursable

cost method recoups all the costs and includes military salaries. The predetermined rates method excludes military salaries and can be used to recoup prior years' losses. Finally, the fixed cost method is a contractual agreement with the price determined from the application of predetermined rates to the expected scope of the project.

Industrial funding extends several significant advantages to an environment in which services are rendered to other activities. To begin with, the relationship between the industrial activity and the customer is altered to one of "seller - buyer." On the one hand, the supplying activity must accurately define the work and equally as important must provide a precise cost estimate. On the other hand, the client activity must be cost conscious since no longer is the good/service "free." In short, the customer must plan better in budgeting for appropriations required to buy needed work. Second, the cost accounting system, which is mandatory, allows costs to be related to the specific job. In effect, this provides visibility of "total cost per unit" for products and services. This visibility precipitates additional benefits. Not only is effective control of costs provided but also standard pricing is developed and accurate costs can be projected. Additionally, since the services must be paid for, the buyer can be critical of the deliverables. This tends to contribute to lower unit costs of production. More importantly, services would be requested judiciously and only the needed services would be requested. Next, the NIF as a working capital fund affords greater freedom and flexibility when compared to the congressional appropriation funding cycle. Finally, the consolidation of similar activities under the NIF concept serves to mitigate duplication resulting from the availability of like services from comparable facilities. [Ref. 8]

As previously mentioned, the goal of DOD working capital funds is to recover all costs and work to a zero profit. From a conceptual point of view, costs, both direct and indirect, are billed to customers in such fashion that total reimbursement would be received. In other words, the cost to the customer should be the cost to the industrial activity. This would allow the funds received in payment to restore the working capital fund so that continued operation can be financed. Under a nonprofit system, cost overruns are in effect losses but they are considerably different than "losses" experienced in a private concern as reduced profits. In reality, NIF losses are manifested as a decrease in the capital of the fund. Temporary profits (increases in the corpus) also occur. These temporary profits (and losses) are considered when budgeting on a "break even" basis. In order to return the accumulated operating results to zero, rates are adjusted. By dint of DOD rate stabilization policies, rates are established for NIF activities and are expected to remain in effect for the entire fiscal year with changes made during the fiscal year only upon the approval of the Assistant Secretary of Defense (Comptroller).

D. RATE STABILIZATION

One of the major criticisms contained in the GAO report concerned the inability of user activities to plan or budget for the acquisition of needed services. Stabilized rates provide a means of alleviating this problem by permitting customers to plan projects based on known rates rather than estimates. An additional benefit results from the elimination of cost growth which may preclude the completion of all projects planned for a particular fiscal year. The mechanism by which stabilized rates operate is relatively straight

forward. NIF activities establish fixed rates in a manner appropriate to the service provided (for example, CPU time, man-hour of analyst time, etc.). Of course there may be more than one rate based on the structure of the organization, the diversity of the workload, and other considerations.

In developing and establishing the fixed rates, the NIF activity must comply with the provisions NAVCOMPT Instruction 7600.23b which stipulates that rates will be aligned "to recover operating costs". Further, the directive requires that gains and losses "will normally be offset during the year following their occurence and will be reflected uniformly in the rates of the Activity Group." Unfortunately the repetitive nature of the review process for stabilized rates results in proposed rates being adjusted at various levels in the command chain. Consequently, rates actually implemented represent adjustments and modifications to the original locally developed rates (bottom-up approach). In short, local control of rates has been surrendered in favor of greater centralization at the Activity Group level or higher. Part of the consequences of this loss in autonomy at the local level is that variances will almost always exist between the stabilized rate billings and the actual costs. This has contributed to the condition in which an industrial activity is always in a position of making a profit or a loss and retroactively working toward zero profit (or loss). It is a problematic situation since a profit or a loss is recognized only after the next year's rates have been established and the offset for that particular profit or loss is not implemented until the establishment of the third year's rates. In a very real sense the industrial activity's operation is extended from an annual to a cumulative triennal basis. [Ref. 9]

E. IMPLICATIONS OF RATE STABILIZATION AND NIF CONVERSION

Since stabilized rates remain in effect for one year and striving to achieve a zero cumulative profit/loss requires three years, NIF funding of NARDACs contributes little in the way of performance measurement. This is particularly true when considering the activity commander's relatively short tour length. In mitigation of this situation, however, the previously mentioned loss of autonomy on the part of the activity commander must be considered. [Ref. 9]

Another implication of the rate stabilization process centers around the submission of budgets by the user activities. By the time the stabilized rates are announced, the user's input for the annual Presidential Budget has already been submitted. The final stabilized rates are available only in time for the construction of the apportionment year column of the next year's President's Budget. In short, rates are stabilized about one year too late to be used as an effective planning tool for appropriations budgeting. [Ref. 8]

There are other implications that merit mention. NARDACs provide regionalized services where local prices for various commodities , e.g., labor, utilities, etc., are very likely to vary for different regions. In other words, the cost of providing the same service may be different depending on the region but stabilized rates impose the identical prices for that service. This is of major concern to a NARDAC Commanding Officer (CO) since the CO may be in the unenviable position of having to charge a far higher rate for a similar service that another NARDAC provides at a lower rate because of more favorable local prices for labor utilities, etc. [Ref. 8]

In the short term, rate stabilization is prone to mask the true cost of operations at the NARDAC. An obvious

example of this situation occurs when an increase in costs (e.g., telecommunications costs, utilities, etc.) cannct be passed on to the client activities because of the stabilized rates. The end result is that customers have no incentive to conserve since the rates are fixed and therefore the costs are absorbed by the industrial activity until recoupment can be effected. [Ref. 9]

Largely because the NIF concept requires the customers to reimburse the prcvider of the services for actual DP services (CPU time, systems analysis labor, etc.), some form of a computer chargeback system is essential for capturing usage data by customer. Fortunately, the informal chargeback system implemented at NARDACs prior to fiscal year 1984 was adequate for this purpose and it greatly facilitated the conversicn of NARDACs to the NIF system.

F. EFFECTIVENESS OF NIF FOR COMPUTER SERVICES

Partly because the informal chargeback system which complemented NIF was in-place, industrial funding of NARDACs was implemented relatively painlessly. Most important, the NIF system seems to have remedied the criticisms levied in the GAO report as well as to have met Navy financial management requirements. This can be made readily apparent by a brief evaluation of relevant factors in comparing the system at the NARDACs prior to NIF funding with the system as it is now with NIF implemented. To begin with, industrial funding provides for the accumulation of the full costs (both direct and indirect) for providing the data processing services as opposed to RMS which provided only the direct costs. Second, NIF allows full cost recovery by permitting the NARDAC to charge customer activities for the full cost of jobs based on the costs accumulated by the cost accounting system. This

is in contrast to mission funding which permitted the recovery of only direct, identifiable, "out of pocket" costs for services provided to fulfill unprogrammed requirements. Next, industrial funding provides cost data sufficiently accurate to facilitate decisions on future enhancements and replacements (i.e., cost - benefit decisions). Moreover, the buyer-seller relationship aspect of industrial funding forces users to be cost conscious and places the user activity in the position of having to decide on requirements and to justify them. NIF also makes possible the accumulation of cost data on both a program basis for the customers' budgets and on Data Processing basis of special interest to the NARDAC budgets. Regarding stabilized rates, customers can better rely on receiving the work they had planned for at the budgeted cost (although this is not always the case, it is better than with RMS). With respect to demand for services, industrial funding provides an accurate representation of user activity requirements, thereby permitting sufficient justification for additional equipment, personnel, etc. Finally, NARDACs are freed from the exacerbating annual appropriations process since working capital funds are employed in its operation. [Ref. 6: pp. 96-102] In summary, the Navy Industrial Fund system for NARDACs seems to be the only viable alternative available to satisfy GAO guidelines and to remain within financial management guidelines of the Navy and the Department of Defense. Whether it works or not is largely an issue of perception.

From the user perspective, the chargeout system seems to suffer from the typical unsatisfactory consequences of most chargeout systems. First of all, the charges that appear on the periodic statements for the users are relatively complex and unintelligible to the less sophisticated user manager. Moreover, there are no provisions for holding the NARDACs responsible for inefficiency variances. The principal

mechanism for this is the seller/buyer relationship between NARDACs and their clients.

As previously mentioned, the introduction of stabilized rates into the charging algorithm causes artificial prices in relation to the current true actual costs. Therefore, in any given year the charges do not relate to the incremental costs associated with the service provided. Although the stabilized rates provide a measure of predictability, the more critical issue for customer managers may be primarily one of how much the service costs. The implementation of stabilized rates together with the chargeout system may mask this needed information.

IV. LINKING COMPUTERS

A. INTRODUCTION

The reasons for linking computers whether in a local area network (LAN) or in a long haul network are very similar to those for distributed data processing. The significant developments in both hardware and software have resulted in a reduction in the physical size of data processing equipment as well as an increase in speed. This, in turn, has resulted in a shift away from the large centralized computer facility of the 1970's. There were many factors for this shift.

To begin with, the era of minicomputers and microcomputers contributed to the cost of processors declining at a rapid rate. It became evident that a computer system could be comprised of many processors if the application required and at a small incremental cost. Along with this factor, the concept of a single data processing center which conducted all the computer related activity for an organization was subverted by user demands for personal computing resources. In the beginning, these microcomputer "work stations" were permitted to proliferate at an uncontrolled rate. As users became more sophisticated in the use of their personal machines, an increased awareness of the potential of processing power resulted. The situation described in the foregoing is consistent with Richard L. Nolan's model of organizational learning in regards to ADP. Briefly, there are four stages in Nolan's model. Briefly, they are

1. Initiation,
2. Contagion,
3. Control, and

4. Maturation.

The initiation stage entails an organization's identification of a technology that may be suitable for use. It is treated by the organization in a similar fashion as a research and development project would be treated. The second stage involves a proliferation of the technology caused by experimentation and rapid user learning and acceptance. In other words, user awareness of the capabilities of the technology help cause the technology to become contagious. The control stage is characterized by management's concern to ensure efficient utilization of the now widespread technology. The maturity stage occurs when management controls are in place and it suggests that further transfer of technology is not possible. [Ref. 10]

In the context of Nolan's model, the initiation stage quickly transitioned to the contagion or proliferation stage. From the contagion stage it is easy to see how management interceded in an attempt to gain control (Nolan's third stage). The principal effect of management's attempt to gain control was the convergence of two formerly separate technologies. Unfortunately, the two technologies, data processing and telecommunications, had different management practices and problems were encountered in their merger. [Ref. 10]

One key difference between telecommunications and automated data processing concerns their evolution and business environment. The telecommunications industry had a "head start" and steadily evolved over a much longer period of time than the computer industry. Another key factor was the monopolistic nature of telecommunications services as opposed to the more competitive nature of data processing. Although this has changed somewhat with the divestiture of AT&T, many of the management influences and impressions remain. Fundamentally there were several differences in the

management concerns for the two. On the one hand, the acquisition of telecommunications services was a passive problem. Since AT&T was viewed as the only source for telecommunications services and prices were seldom if ever negotiated (tariffs were regulated), there was little for management to do but to accept these costs as "sunk". On the ADP side, the purchase or lease of computing power was a major economic consideration and subject to cost/benefit analysis as well as possible capital expenditures.

A brief examination of corporate trends can illustrate the convergence of the two technologies. AT&T and some of its divested companies (as well as other independent communications companies) have moved into the computer market and are building, marketing, and selling their own computers. IBM and other computer manufacturers are building complete communications systems both for company use and as product lines. The point of the illustration is that the technologies have converged and have become integrated with each other in many respects. The formerly separate services can be acquired from a single source (supplier). There remain, however, the ubiquitous concerns for managing the overall systems and with which community primary management responsibility should rest.

This chapter will seek not to address the management issues yet but to provide a basis for further discussion of computers and data communications. Brifly, this chapter will focus on the reasons for linking computers, the uses which can be derived from linking computers, and some of the ways computers can be linked.

B. THE REASONS

As previously stated, the computer industry is relatively young when compared to the telecommunications

industry. In its short life, the computer industry has made enormous progress and evolved from strictly specialty applications (primarily scientific) to providing general systems for a variety of applications (process control, operations, etc.). In fact, data processing or more accurately information systems cross many organizational boundaries and have become acknowledged as requiring strategic positions in organizational structures. This seems to be a natural evolution since resources must be managed and management includes higher level planning efforts as the importance of the resource increases.

There are several factors driving the trend towards linking computers in some form - normally in a network. The first, of course, is the already mentioned proliferation of microcomputers and in some respects the mainframe computers. In most cases, these computers were acquired without regard to needs or requirements of other organizational entities. The end result of this uncoordinated effort was the widespread duplication of data as well as inaccessibility of needed data and, most important, loss of management control. The lessons learned from the evolution of the large mainframe computers were not heeded. In other words, microprocessors were allowed to spread randomly and the lessons of structured or incremental evolution were largely ignored. Consequently, resource sharing was made difficult if not impossible. When management finally became aware of the potentials and capabilities of sharing computer resources, it was discovered that the efforts to integrate the various systems would be significant. Nevertheless, the principal goal formulated by management almost unanimously was to tie together or connect the various computer resources so that needed information could be fetched from wherever it was located. Naturally, this information could be located at several physical sites and could be combined to provide more

meaning. Put in simpler context, the overall reason for linking computers is to allow data, processing power, applications, or any other computer resource to be conveniently available in a transparent manner to users. Transparency in this case alludes to the physical location of either the user or the computing resource.

A second reason for linking computers is to provide for increased reliability. Increased reliability can be achieved if back up systems are available but this is not always economically viable. Connecting computers to each other can provide alternative sources of computing capability in the event of a disruption of services at one node. With stand alone processors, a failure in the system will suspend services for the duration of the failure. In many applications, this loss of computing power can be catastrophic to operations. A good example of this is the Trans World Airlines (TWA) reservation system which is implemented by a star network. The loss of computer resources at TWA would virtually shutdown its operations. This is the principal reason the TWA network also includes an identical central processor for its back up operations. The TWA system is at one end of a continuum where reliability is extremely crucial. At the other end of the spectrum where reliability is not a factor, a stand alone computer will provide the necessary capability. Between the two extremes are degrees of reliability which can be selected by choice of network architecture. The choice is largely judgemental and varies with many factors including corporate culture and maturity of the organization with respect to information processing. In most cases networks allow some flexibility in the event of the loss of a single computing node by providing for substitute computing power elsewhere on the net.

Another important reason for connecting computers has to do with distribution of processing power. In a large number

of applications, it makes sense to capture and to process the data locally. Previously, communication costs were lower than computing costs and it was sensible to capture certain data at dispersed locations for later transmission to central computing facilities for processing. With the enormous decline in computing costs, many processing applications can be offloaded to satellite sites cheaply. These applications may include data collection, data storage, data base processing, routing, editing, analysis, and a host of other functions. These computing functions scattered at various locations can provide many benefits including some degree of local user autonomy in the computer environment, the potential for greater user-productivity, access to remote data as well as increased processing power, and decentralized operations. Some additional benefits include more accurate input data with increased user involvement, greater user responsibility for input/output/cost effectiveness, and increased user influence in optimizing operations.

The final reason for connecting computers is somewhat related to the foregoing reason. With the ability to distribute processing power there has also been the vastly improved cost/performance ratio of small computers in relation to the large computers. With applications or functions which do not require the extensive instructions nor the high powered arithmetic and data manipulation operations available on the large mainframes, there has been a growing trend to design computer systems consisting of many smaller computers in a network. These networks can be often designed in such a way that they can outperform single large mainframe computers. This often can be achieved at more economical costs and provides greater flexibility for expansion (i.e., adding computers/nodes). Additionally, there are many "off-the-shelf" application packages available virtually eliminating software development costs. Software design

would in all likelihood be much simpler and the complexity normally associated with large computers can be largely eliminated. This trend has occurred primarily when the processors can be physically located close together and is referred to as local area networks (LANs).

C. THE USES

Linking computers provides many uses in various forms. However, the uses fall essentially under three basic categories. The first category of computer network use involves access to processing power. The second concerns access to data and the final category relates computer networks to communications in the generic sense. Each of these categories will be discussed in turn in the following paragraphs.

As briefly discussed in the section on the reasons for linking computers, the distribution of processing power offers great flexibility and economy in an organization. Where most of the processing can occur locally but occasional access to a larger computer is required, significant benefits can result from having access locally to a computer capable of greater processing power. A good rule of thumb is the 80/20 criteria. 80 per cent of the processing should be accomplished locally and 20 per cent at the larger remote site [Ref. 11]. Included in this concept is the availability of applications or programs not available locally but available at remote locations. The Defense Data Network (DDN) provides a good example of this idea.

Comprised of the Military Network (MILNET) and the Defense Advanced Research Projects Agency Network (formerly ARPANET), DDN employs packet switching technology to connect various heterogeneous host computers into each network. Transparent gateways provide inter-net connections. At each node various application programs are resident. Some are

common to many hosts and some are unique application packages. By simply using the universal "TELNET" command, another host may be accessed and the application programs of that particular computer may be used as if the programs were resident at the original host (assuming access authorization has been granted to the user for both sites). Achieving the processing power of an entirely different host is accomplished in a completely transparent manner. In other words, the distance of the remote site remains hidden to the user.

In similar fashion the concept can be scaled down to a much lower level. In providing the capability to link microcomputers, local area networks and office automation technology have generated mass appeal for such links and the concept appears to be on the verge of receiving wider acceptance. The implications of allowing multiple users at various locations to share software application packages include:

1. more efficient and economical use of "off-the-shelf" software;
2. less redundancy and costs of identical applications; and
3. increased individual user productivity.

This can be best illustrated by examining the approach of Chemical Bank, the nation's sixth largest bank in meeting its information system needs.

Chemical Bank adopted a portfolio approach in implementing its distributed data processing system. Within the bank's system, there exist three separate systems each with three different levels. Placed at the top level in each system, is a centralized data processing center. The next level contains multiple office automation systems (OAS) and each OAS is geared towards a particular function of the office. The lowest level contains microcomputers for personal computing and are hooked into the office automation

systems. Although the hardware is diversified, software consistency or compatibility is enforced down the hierarchy. The diversified hardware is consistent with the bank's portofolio strategy or approach. More specifically, with different hardware suites (capital investments) risk is reduced and technological uncertainty is dealt with. An added advantage of diversifying its computer hardware is that the bank will have a better opportunity to remain at the frontier of computer technology.

Functionally, each of the three systems mentioned above contain a large scale mainframe used primarily for financial data processing. Minicomputers serve as control hardware for the microcomputers and are considered "mainframes" at the division level. The microcomputers serve as workstations for various functions including terminal emulation and word processing. As terminal emulators, the microcomputers are permitted to download data and to access certain software applications. Software is entirely compatible and can be transported both within each level of a system and across the three separate systems. Although this is a relatively stringent requirement (acquisition of new software must adhere to this requirement i.e., be capable of operating on all three systems and at each level within a system as well), this consciously imposed management decision permits a high degree of flexibility for the sharing of software application packages. A side benefit is that training, maintenance, and personnel skills are facilitated.

Another important use of networks is to provide access to data located at different and often distant sites. An effective way of illustrating this category of application is by describing briefly a system currently in place.

The Naval Aviation Logistics Data Analysis (NALDA) System is a major ADP system installed for the Naval Aviation Logistics Community. Although NALDA is typically

thought of as a centralized, integrated and uniform data bank of aviation logistics data, the true purpose of the system is to provide interactive real-time access to this data by the aviation logistics community. Not only is real-time access available but there are also provisions for extensive analytical capabilities available to engineers and logisticians at remote sites. The end result of this capability is to assist the user in solving complex problems and in making improved decisions. The NALDA concept was spawned by the recognition of the increased importance of rapidly obtaining accurate logistics data, and the realization that even if the information was stored in some mechanized form that often it could not be retrieved in time to be used effectively for managers to make fully informed decisions. When data was available in hard copy form it was quite often in the wrong format, sorted on the wrong parameter, or not available from a single source.

A bonus effect of the NALDA system was the reduction or elimination of unnecessary, redundant, or overlapping data. This was accomplished by the use of data base management technology. Another benefit of using the real-time NALDA system was in the analysis process itself. With the knowledge that analysis is an iterative process, it was obvious that answers to questions frequently generated more questions and that each successive question was more complex. In short, remote real-time access to a large universal logistics data base in this case provided capability for aviation logistics managers to make complex decisions in a timely fashion. Although from varied sources, the data was made available in one central system and permitted logistics manager to quickly obtain relevant and accurate data.

It is readily apparent that data is an important element in information resource philosophy. With this realization, it is easy to understand previously far-fetched predictions

of everyday personal applictions as well. For example, it is possible for travel agents to work at home with nothing more than an inexpensive ($200) home computer and a MODEM. These travel agents have access to airline schedules and some passenger reservation data and can virtually perform all operations at home. The natural extension of this idea is to make this service available to all individuals. In other words, travel/recreation arrangements or any type of reservations may be made one day entirely within the confines of one's home. There are many examples of personal applications and they are only limited by the imagination. Another example is the automated newspaper. With the volume of information in just one Sunday newspaper (New York Times, for example), it is a wonder how anyone could ever completely read it in one day. Of course, the information is selectively read because different people have different interests. This idea can be applied to automated newspapers in a much more efficient manner. A reader could more easily focus on specific interests or have the information tailored to a particular taste. For example, a reader could subscribe to classified advertisements for homes only or for automobiles only. A reader could obtain the latest and most up to date information on stock market activities, on sports, or on virtually anything now contained in a typical newspaper and access could be made almost instantaneously. If nothing else, the savings on paper alone would be very significant.

The third and final area of network use has to do with communications. Computer networks lend themselves to providing an effective medium for communications and the use of computer networks as a communications medium has gained widespread popularity in the recent past. An examination of the business sector will support this contention. Electronic mail has gained increasing popularity and

although it has yet to achieve widespread acceptance, it seems destined to be commonplace in the future. This can be best illustrated by examining a form of electronic mail, electronic funds transfer (EFT) and its impact on the banking industry. The banking industry has found that significant savings can result from reducing (or eliminating entirely) the delays in receiving scheduled periodic payments (for loans etc.) This delay is usually referred to as a "float." For example, many banks offer EFT for payment of mortgage (or other kinds of loans) to the lending institution (both must participate in EFT). This frees the borrower from having to remember to mail the periodic (usually monthly) payment and at the same time allows the receiving institution to "use" the payment immediately without the normal postal system or other kinds of delays. In the aggregate, the savings accrued from the interest on the individual payments accumulates to a significant amount. Other businesses which operate on a credit basis will eventually take advantage of this service.

The natural extension of networks as communications media is teleconferencing. It is not inconceivable in the future that conferences, meetings, or appointments could be conducted without ever moving from one's work location. This will be enhanced by the availability of video equipment connected to the computer network. Many applications can be easily imagined. With the availability of memory and playback features, missed meetings could be "attended" at one's leisure. Routine or uninteresting portions could be completely removed or only important portions of briefings need be reviewed. Summaries by any particular categories could be made available at the touch of a button. The applications are almost limitless.

D. WAYS TO LINK COMPUTERS

There are many ways to link computers and fundamentally when computers are linked they are thought of as comprising a network. Rather than list and describe all the possible methods of connectivity, this section will selectively describe the schemes of interest. Although there are three different sources for standardizing connectivity protocols:

1. manufacturers - IBM, DEC, etc.;
2. standards organizations - International Standards Organization;
3. common carriers - AT&T.

This chapter will concentrate primarily on the vendor sources which seem to be currently dominant.

In local area networks, three prevailing methods for linking computers have been adopted by the major suppliers. Therefore, it seems only fitting that these should be described. In the long haul arena, the connections of the Defense Data Network (DDN) are of primary concern and therefore descriptions of other types of connection such as radio and satellite connection will be omitted. Each of the methodologies will be presented in the following paragraphs.

With the expectation that IBM will soon enter the local area network (LAN) market, the mere thought of IBM's endorsement should spur on the LAN concept [Ref. 12]. With this in mind it seems appropriate to first examine the methodology expected to be adopted by IBM for tying together computers in a local area network. IBM seems to be oriented towards token passing as the protocol for implementing LANs. In token passing, a specially coded electrical signal or bit pattern (called a token) is continually transmitted throughout the network. Whenever a station desires to transmit a message it must first capture the token. This is done by continuously monitoring for the special bit pattern

as it circulates around the net. As it passes the transmitting station, the token (bit pattern) is transformed to a different bit pattern signifying that the token and the net has been seized and that a message follows. The transmitting station is permitted to attach its message or message packet to the token. Of course all these actions require only a small amount of time. Included in the message packet is the destination address and other important routing information. The receiving station picks off the information as the bits propagate around the network. The token is not regenerated until the message travels back around to the transmitting station. The implications here are that the receiving station must provide some form of acknowledgement and that the sending station may monitor the actual message sent to compare with that desired (to ensure accuracy). Overall, token passing suggests a round-robin opportunity for each station to send a message. Another important implication of token passing is that great care must be exercised to ensure that the token will not be lost. The network would be at a standstill since there are only two modes of operation, listen and transmit (i.e., no station would be able to transmit because the token does not exist and cannot be seized). This leads to the final important implication of token passing. There must be provisions for detecting that the token is lost and for its smooth regeneration. [Ref. 13]

Another popular way of implementing a LAN was pioneered by the XEROX corporation [Ref. 12]. It is commonly known as ETHERNET and employs collision avoidance and detection to control the transmission of messages on the net. In an ETHERNET, all stations monitor the net. If it appears that no station is attempting to transmit a message, a station is permitted to begin a message transmission but must continuously monitor the net <u>during</u> the transmission for the

purpose of detecting any contention for the net. In the event a collision is detected, the transmissions are immediately terminated by the stations transmitting. After a random period of time, a sending station is allowed to attempt a retransmission of its message (if the net is clear) and the cycle of monitoring and waiting randomly is repeated as appropriate. The advantage of this method is that transmission is terminated immediately upon the detection of a collision. In other methods, a complete message is frequently sent before it is discovered that a collision has occurred. Thus, a significant amount of time is saved. The ETHERNET concept offers simplicity and economy for low traffice volume networks. However, in a high density message situation, it becomes extremely difficult to get a message transmitted.

The third and final way (that will be discussed) of linking together automated offices is the star configuration offered by AT&T. As might be expected, the star network for LANs was heavily influenced by the structure of the telephone system. It is analagous to the telephone system's central switch configuration wherein each telephone is connected by its own separate line to a central facility. Interconnection between any two phones is accomplished at the central site. In the same way, computers can be linked by a central computer. All information packets must pass through the central computer which serves fundamentally as a controller. As a controller, the central computer provides the connectivity and directs the flow of information packets to the desired destination. It is by far the simplest way to link computers in a local area network and it is easy to implement. The biggest disadvantage of the star LAN is that if the central site fails, all traffic comes to a complete halt. It is probably for this reason that AT&T also offers collision avoidance and detection protocol similar to ETHERNET. [Ref. 12]

In the long haul arena, primary focus will be on the DDN since its use has been mandated for all data communication needs throughout the Defense Department. The DDN employs packet switching technology pioneered by the ARPANET. ARPANET was started in 1969 and became operational in 1971. It originally included 23 host computers and has expanded to well over 100. To gain better insight to the DDN linkage, a brief description of ARPANET will be provided.

ARPANET is heterogeneous network in that many different computers are on the system. Interface is accomplished by minicomputers. Interface Message Processors (IMPs) provide capability as store and forward packet switches which can accomodate up to four host computers each. Terminal Interface Processors (TIPs) are store and forward packet switches which can accomodate up to three host computers and 63 terminals each. Terminal Access Controllers (TACs) are stand alone terminal controllers attached to IMPs as hosts. As previously mentioned, ARPANET is a store and forward packet switch network. Each packet contains 1000 bits and there are at least two separate routes between any two nodes. Communication links are wideband and supplied by common carriers. Message transfer time is less than 250 milliseconds and one megabit can be transmitted 1400 miles for less than 50 cents.

In contrast to message switching which has no limit on the length of a message, packet switching imposes a strict upper limit on the block size of a particular transmission. This has several advantages. To begin with, no sender can monopolize the transmission lines for more than the length of a packet. Additionally, message packets can be handled in main memory precluding the requirement of providing additional disks for buffering variable length messages (as in message switching). Finally, packet switching technology provides for excellent handling of messages in an interactive environment.

The concept of packet switching is relatively simple and straightforward. With alternate routes available between any two nodes, a packet is transmitted through whatever route is available at transmission time. If needed, the packet can be stored at intermediate nodes for transmission to the ultimate destination as available transmission paths permit. For multi-packet messages, the implication is that the first packet may be examined at the destination location even before the entire (remaining packets) message arrives. This reduces delays and increases throughput for the network. In short, store and forward packet switching networks transmit packet sized messages from IMP to IMP in a hop scotch fashion. [Ref. 13]

The charging algorithm for store and forward packet switching networks merit some discussion. With standard telephone circuitry, charges are typically based on connectivity time and distance. Traffic load is not a consideration. In packet switching, the charge is usually based on the number of packets (or bits) and the connect time. Traffic density may or may not be a cost factor.

V. ADP/COMMUNICATIONS

A. SCOPE

The computer industry is a major component of the national economy and the business/government way of doing business. The industry is still growing and obviously shows no signs of slowing. In 1970 spending on data processing accounted for 2.1% of the GNP and estimates have projected that by 1985 the spending figure will have reached 8.3% of the GNP [Ref. 14: p.101]. A sizable part of the explosive growth in spending is brought about by the emergence of new technologies. The move toward distributed and shared data-bases within a company, networks (both local area and long-haul) and office automation, just to name a few, is the direction of the day.

Why are these technologies so popular? As noted in the previous chapter, two underlying reasons seem plausible - 1) the cost of computer processing has declined considerably over the past few years and 2) the perceived increased potential for greater efficiency and effectiveness offered by the newer technologies. An IBM report in 1982 high-lighted the trend of lowered processing cost stating, "Processing that cost $1 in 1952 cost $0.0076 in 1981" [Ref. 15: p.8]. Efficiency is a strong motivator in any business situation and many believe distributed data processing/networks are a step in that direction. These sentiments were echoed by author M.P. Mariani, for example, when he wrote,

> "The trend towards multiple processors/computer networks - distributed data processing offers the potential for more cost effective throughput, improved system reli-ability and natural growth paths among other features." [Ref. 16: p.31].

There is one common thread among many of these new technologies such as networks, "smart offices", and office automation - data communications. In all cases, whether between word processors sitting on opposite sides of a room or computers standing half a world apart, the flow of data is the key that allows the system to function. Mariani emphasizes this point in his chapter on data processing systems by saying, "Hardware reliability is determined by both the reliability of the nodal complex and that <u>of the network connecting</u> the nodes" [Ref. 16: p.xiv].

As these new technologies grow so will the demand for efficient and cost effective data communications. Word processing and office automation are front page topics of current times and the phrases are often used interchangeably. However, the key to office automation is not just the act of word processing, rather it is the combining of word processing with new advances in such areas as communications and database technology that will account for significant increases in efficiency and effectiveness within the organization. One example of such improvement occurred at Western Union where, after several work stations were networked, a monthly report that previously took 13 days to prepare could now be done with fewer people and completed in 5 days [Ref. 17: p.102]. Time is money and where the introduction of new technologies results in increased employee efficiency and effectiveness it can usually be related to a dollar value.

If data communications is closely related to these new technologies then appropriate questions to ask might include:

1. Is the acceptance of these new technologies here today or is it on the horizon?
2. How applicable are these new technologies to the broad spectrum of organization sizes?

The answer to the first question can often be gleaned from popular trade journals and publications. It is close to impossible to find an issue of publications written for and by computer system designers, operators or users (government or civilian) which does not contain articles on networking or office automation. An article in a recent issue of one such publication proclaimed what is fast becoming an accepted fact, "The era of office automation is, without a doubt, here" [Ref. 18: p.68]. The same article went on to address the second question by stating,

> "Once considered applicable only to large organizations, the need for and cost effectiveness of office automation are having an increasing greater impact in smaller, single-site, companies" [Ref. 18: p.68].

The U.S. government is certainly not immune to the effect of these new advances. Arlene Triplett, associate director for management, Office of Management and Budget, (OM&B) recently said that "over the next few years, federal agencies will procure tens of thousands of smale scale end-user systems and <u>the networks to interconnect them</u>" [Ref. 19: p.44]. Triplett also indicated that OMB was requiring all federal agency managers to develop and report on strategies for several areas. Included were: [Ref. 19: p.44]

1. applications of new technologies to IRM (Information Resource Management) activities in a manner that is efficient and cost effective to the government;
2. the reaching of broad interconnection and integration of (computer) systems; and
3. taking advantage of exploding technological developments (in the tele/data communications field) to maximize productivity and integrate the various media.

From the discussion above it is obvious that data communications and the technologies that utilize it are big business. Just to illustrate the point, a minor sampling of recent government contract awards included: [Ref. 20: p.72]

1. A joint U.S. Air Force/Department of the Navy, $29 million, one year contract for the purchase of micro computer systems.
2. A five year, $22.5 million contract by the Department of Energy for operation and systems integration support services.
3. A ten year, $36.4 million U.S. Army contract for a network to support its recruiting process.

The above sampling represents only a very small number of the hundreds of examples of the money spent on systems which have at the root of them the process of data communications. The point is that in an area of such expansion and of such large investments of money, the utilization of proper management becomes more than just important, it is paramount.

B. COST IDENTIFICATION

As alluded to earlier, data communication is not a free good, in fact according to one recent article, " Moving computer data, for instance, is already a $4.5 billion business and growing at more than 20% per year" [Ref. 21: p.74]. Data communications is big, but, the problem is in determining how big. What does an organization really spend on data communications? It is a question that is extremely hard to answer and in some cases, because of its difficulty, just ignored. Data communications however, is becoming so integral to the ability to utilize the power of computer processing effficiently and effectively that it can no longer be taken for granted. Information is rapidly becoming

recognized as a resource, a valuable one, to be managed and data communications can easily be defined as the flow of the basic units of that resource called information. One can not truly be managed without managing the other.

It can be said that one can not truly manage what one cannot measure. If an organization does not know how much of a resource it is using or what the use of that resource is costing the organization, how can standards by which to manage the resource be set? The most optimistic answer to that question would be, "with great difficulty." The accurate identification of data communication cost is growing even more difficult as time passes. One of the developments that is causing the confusion is the meshing of telecommunications and data communications. The two, once treated as unique and separate entities, are by and large becoming undifferentiable. A good example of this is the Federal Communication Commissions Computer II decision. In essence, due to the difficulty of distinguishing between telecommunications (which comes under FCC regulatory status) and data processing/communications (which is not under FCC control) the "commission gave up trying to classify various services and types of equipment as belonging to one or the other" [Ref. 22: p.202]. The trend to merge the two is being carried forward by many large corporations. Chase Manhattan Bank, for instance, has been reported as planning to integrate voice, data, and video on its cable system in the New York City area [Ref. 22: p.200]. The use of dedicated data communication lines affords a much easier method of managing data communications cost , but, many believe it to be much more cost effective to combine their telecommunications and data communications. The proliferation of MODEMs in the workplace is just one example of the trend toward making data communication as simple as picking up a telephone.

Because of the difficulty in separating the two, many organizations choose not to try. For example, a review of several Information System Support Plan (ISSP) documents submitted to NAVDAC from major activities for FY 1983-1989 indicated numerous ambitious plans in progress or on the drawing board for the development of networking projects. Some of the ISSPs broke out teleprocessing cost, most however did not. It would seem that the trend is to leave the development of the data communications to support these networks up to the contractor (at a price) and then to allow the cost of operating, at least in part (dial-up), the data communications to be dissolved into the telephone bill. The philosophy in this case would seem to be - if you can't find it, then it must not exist and if it doesn't exist, then you don't have to manage it.

It seems obvious from the direction, discussed previously, given by OMB, the plans detailed in various ISSP documents and general business trends that networks, office automation, etc. are directions of importance to the Navy and to Navy ADP specifically. As observed by a National Academy of Science report the reasons are straightforward,

> "In many possible ADP applications areas, existing word processing equipment, with its versatile interactive editing capability, could be employed as a front end data preparation subsystem; adding processing and communicating capabilities to such equipment greatly improves its usefulness at modest incremental cost" [Ref. 23: p.13].

Should an organization really be concerned with the cost or structuring of these new technologies? Some common sense and several sources say - yes! By and large any network will at some point be facing the effects of the AT&T divestiture and its accompanying change in rate structures. The effect of this was reviewed in some detail in one trade magazine which pointed out that,

> "The recent restructuring of the interstate private line tariffs has created a cornucopia of options and proposals to sift through. The restructuring will have a significant impact on the cost of multipoint-line data networks, and cost increases of <u>35%</u> <u>or</u> <u>more</u> are not unusual." [Ref. 24: p.113]

The article goes on to caution, "The rapidly changing environment and the resultant uncertainty underline the need for the ability to evaluate the cost of various options" [Ref. 24: p.113].

The "backbone" of the network is not the only cost environment of concern. For instance, Anthony Palerna of RCA Cylix has predicted that the cost of leased private lines (used to hook up the customer to the network backbone) will increase "more than <u>90</u> <u>percent</u> at distances of <u>less</u> <u>than</u> <u>10</u> <u>miles</u>" [Ref. 22: p.194]. The cost of supporting each node in a multipoint network is also expected to rise significantly. In fact some predict more than triple in the very near future. [Ref. 22: p.80]

It is safe to say at this point that data communications is and should be a management concern. It is an aspect of design and of day to day operations that deserves earnest management attention. How the Navy chooses to manage new technologies and the data communications associated with them is the question of the 80's. However, before delving too deeply into the future, the next section will review briefly the current Navy policy and procedure in regards to data communications services.

C. ACQUIRING COMMUNICATION SERVICE

1. <u>Defense</u> <u>Data</u> <u>Network</u>

a. Background

In the past the Navy has basically divided the communications world into two parts - strictly telephone

service, administered by Commander, Naval Facilities Engineering Command, and any other, administered by Commander, Naval Telecommunications Command (COMNAVTELCOM). However, this distinction will no longer exist as of October 1, 1984 when all communications will come under COMNAVTELCOM. Under the area of telecommunications in support of data communications it has further been divided between communications in support of long-haul applications and local data communications.

The military has for some time recognized the advantages of developing and managing its own national data network and the AUTODIN II project was a study aimed at designing a system towards that end. Concurrently, the possible utilization of the already functioning ARPANET was being considered as another alternative. In a Deputy Secretary of Defense Memorandum, dated 2 April 1982, AUTODIN II was terminated and the military departments and the Defense Communications Agency were tasked to develop a Defense Data Network (DDN). [Ref. 25] In that same April memorandum the Deputy Secretary made it clear that the application or use of the DDN was to be establishment-wide. The memorandum specified that, "all data communication users ... be integrated into this common user network" [Ref. 26: p.1]. This decision was emphasized again in March 1983 by the Under Secretary of Defense for Research and Engineering as the use of DDN was directed for support of, "all DoD ADP systems and data networks requiring data communications services" [Ref. 26: p.1]. In January 1983 the Chief of Naval Operations requested that COMNAVTELCOM , "....assume overall project coordination responsibility to plan, program and manage implementation of DDN in the Navy" [Ref. 25]. The CNO letter also requested that "COMNAVDAC and COMNAVELEXSYCOM provide technical support for DDN development as required by the Project Coordinator" [Ref. 25].

b. DDN System Waivers

The Chief of Naval Operations, in March 1984, stated that, "Long -haul and area communications, interconnectivity, and the capability for interoperability will be provided by the DDN" [Ref. 27]. The same instruction also directed all ships and stations to ensure that their system requirements had been submitted to COMNAVTELCOM for inclusion in the DDN Users Requirements Data Base (URDB) and that, if not already utilizing the DDN, "an application for temporary or permanent waiver has been submitted to CNO(OP-941) via COMNAVTELCOM, copy to DCA(B610) and COMNAVDAC(Code 32)" [Ref. 27].

Although waivers for the mandate to use DDN can be obtained, it is intentionally very hard to support. As stated in an August 1983 Secretary of Defense message, "The only request for waiver which will be considered are those which clearly show that the DDN cannot meet the user requirement" [Ref. 28]. The process for acquiring such a waiver is shown in Figure 5.1

c. The TSR Process

The vehicle for gaining tleecommunications lines is the Telecommunications Service Request (TSR). Detailed instructions are contained in several references, including NAVTELCOMINSTR 2880.1B and the Navy Planning Guidence for Defense Data Network Implementation, also produced by COMNAVTELCOM in March 1984. A block diagram description of the process is shown in Figure 5.2 A message request for telecommunication service (known as a Feeder TSR) initiates the process and contains, "....detailed technical information concerning circuits required, locations of all service required and a schedule for start of service" [Ref. 26: p.18]. The Feeder TSR is submitted to COMNAVTELCOM who

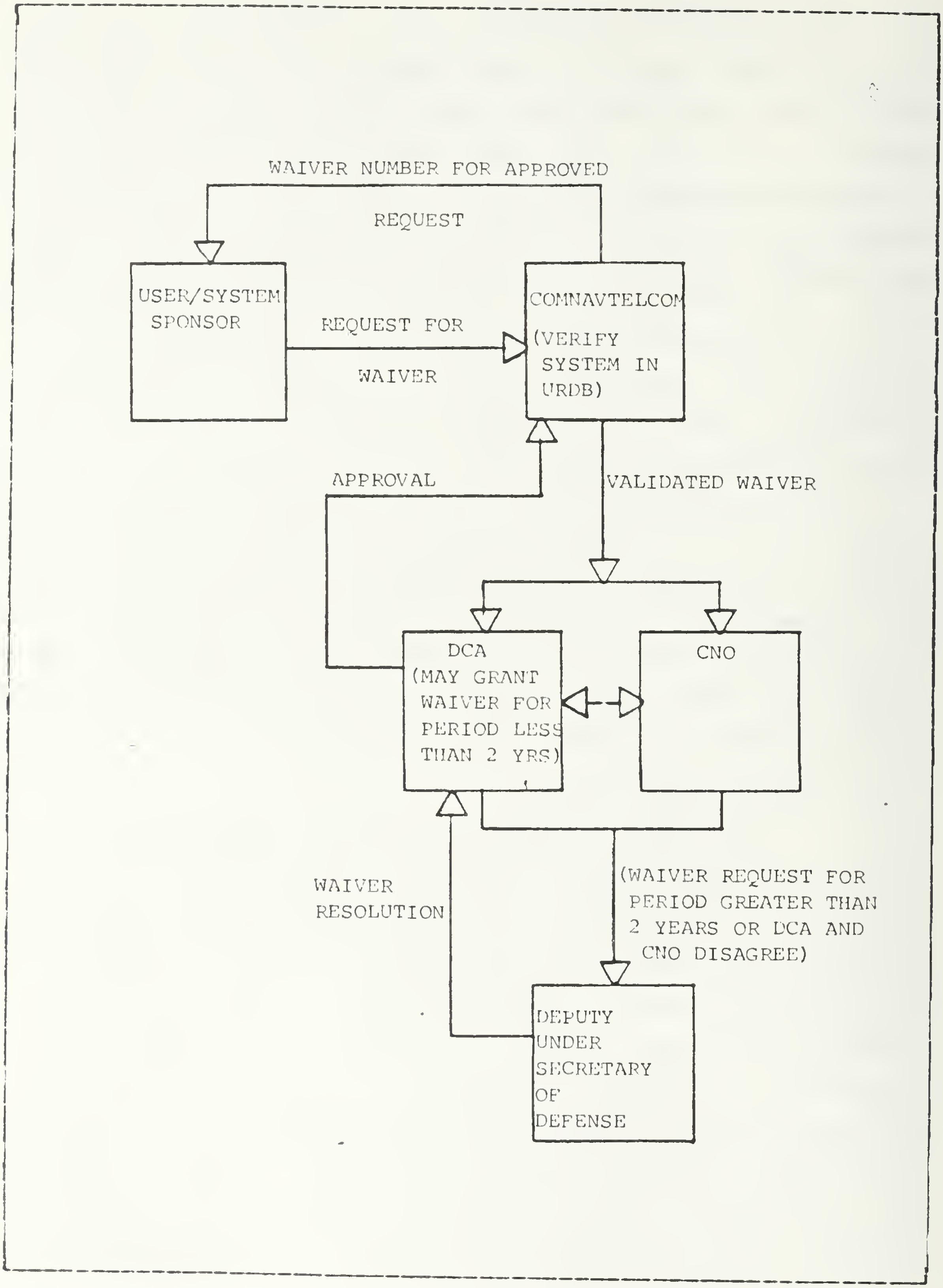

Figure 5.1 DDN Waiver Process.

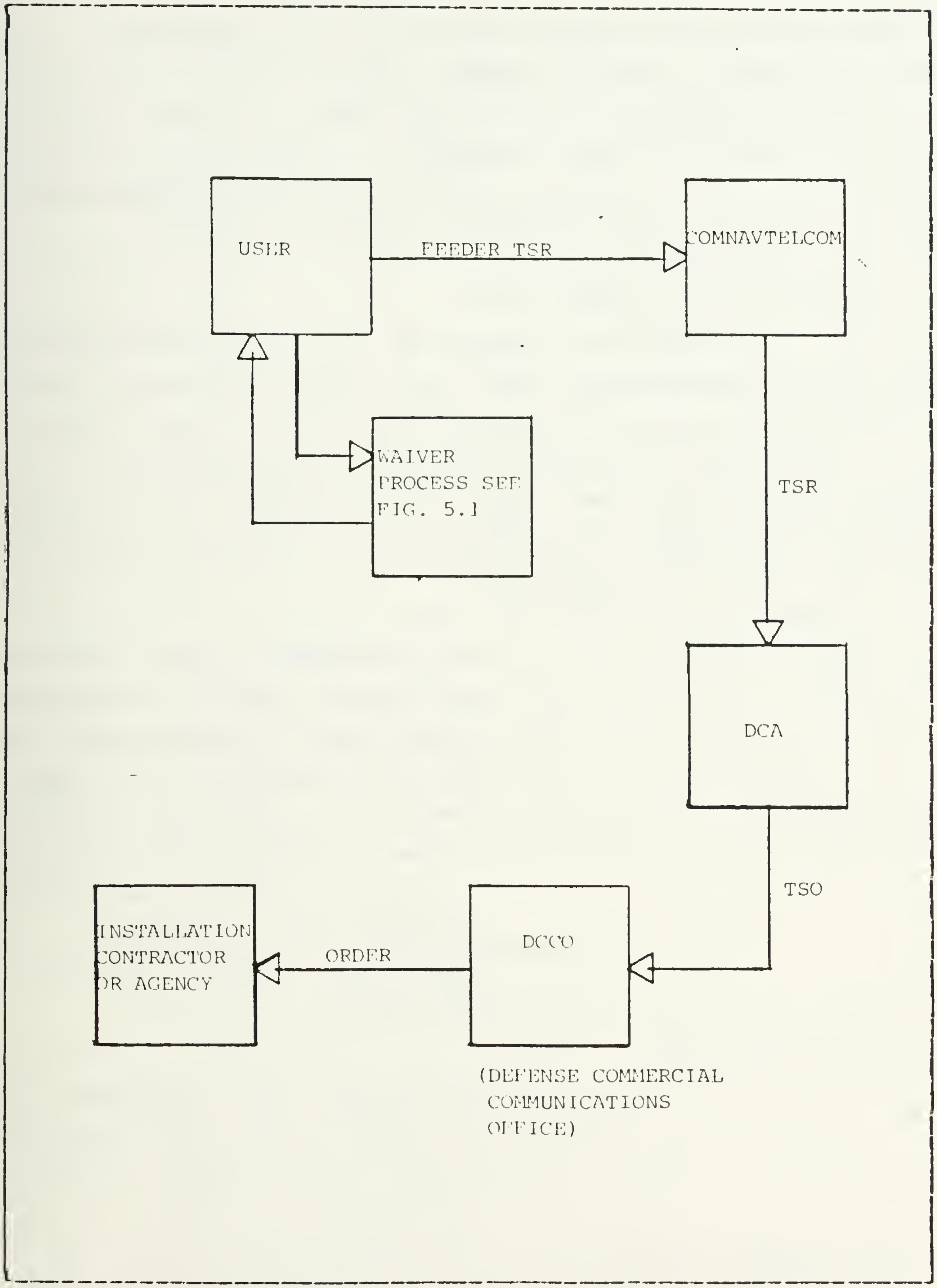

Figure 5.2 Telecommunication Service Request Process.

ensures that 1) the system referred to is contained in the URDB and that 2) if the service requested is for other than DDN connectivity, it has a waiver number already approved and assigned to it. Upon completion of the review a TSR is forwarded to DCA for review and issuance of a telecommunication service order to acquire the necessary circuits.

d. DDN Funding

The DDN is supported by the Communications Service Industrial Fund (CSIF) and the Navy provides monies to the CSIF to support the use of the DDN by Navy subscribers. The programming and funding responsibilities, as broken down within the Navy, are outlined in the Navy Planning Guide for DDN Implementation. They are listed as follows: [Ref. 26: p.A-1]

1. CNO

Provide funds to the CSIF to be used by DCA for backbone operations and acquisition of network components, crypto devices, backbone trunks, access lines and MODEMs, development of "standard" software and acquisition of "standard" host front-end processors.

2. COMNAVTELCOM

Programming and funding to implement the DDN program within the Navy, which includes site surveys of node installation sites.

3. Node Host

Program and fund site preparation, utility support, base cable upgrades, technical control modifications.

4. Subscriber

Program and fund for the following: software interface development, if required; interface hardware acquisition; interface software maintenance; interface hardware maintenance; software acquisition; training; _packet utilization charges when implemented_.

It should be noted that the actual hook-up is at no cost to the subscriber, as the DDN Project Management Office will provide access lines from hosts and terminals to the DDN equipment. Also, for the moment, use of the DDN is at no charge to the user. However, cost chargeback algorithms are under study and, as indicated above, once settled upon users can expect to pay a utilization rate for the use of the DDN network.

2. Local Area Data Communications

Although no hard, fast rules exist that separates "long-haul" from "short-haul" (or Local Area) data communications, 20 miles seems to be brought up as a rough standard. The OPNAV instruction on Navy policy in regards to DDN provides one reference to the "20 mile limit". It states,

> "As a rule of thumb, if a dedicated line/terminal requires a "long-distance" link to access a host system (ie., distance greater than 20 miles, or outside of a host's local metropolitan calling area), it is a candidate for direct connection to DDN" [Ref. 27].

Communications aspects of a large, application-oriented system is approved and managed as part of that major system under the Life Cycle Management concept. But the question that comes to mind is, "What about nonapplication-oriented LANs?". Conversations with NAVDAC, code 30, indicate that this is an area of some concern as there is no current instruction setting standard procedures or a centralized review and approval in regards to this emerging area.

At present, if a command on a base wants to install office automation or tie together various offices within a building, it is generally a decision and funding requirement left up to that local command. If the decision deals with tying together various (and already existing) computers/ terminals spread out on a base, it is one that is to be made by the base commander and perhaps the individual major claimants involved. Even if a command wants to hook into an already existing commercial LAN (say within a large metropolitan area) there is no set instruction to deal with standards of review or approval. The final decision, in regards to stand alone LANs, has been basically laid in the lap of the entity that is going to pay for it. This is not necessarily bad but it does leave room for the introduction of significant problems. In many cases, due to a lack of onboard expertise in such areas and being unsure if any centralized Navy expertise exist, the tendency may be to just call upon the vendor. If the vendor has a good presentation, builds up what seems like definite needs and offers what appears to be the "perfect" solutions to fill those needs, the Navy client will many times give the go ahead. The problems lie in the fact that the same lack of expertise in these rapidly changing technologies is the same lack of expertise that may make the Navy client too dependent on the vendor's evaluation of requirements, problem identification and technological solution. The result may be less than

optimal, both from the standpoint of the user/client and the Navy as a whole.

The idea of helping Navy units and organizations in such areas as: defining data communications needs, evaluating data communications problems, selecting current solutions from current technology, reviewing vendor supplied analysis and solution proposals, etc. is a central focus of this thesis and is discussed at length in the following chapters.

VI. MANAGEMENT ISSUES

A. DATA COMMUNICATIONS - SERVICE OR RESOURCE?

The question asked in the heading of this section is a central element in the management of an information system. The decision on the classification of data communications is one that will define the boundaries of the system to be managed under the heading of Information Resource Management. The question is really one that runs deeper than just a dictionary definition because the classification also affects the prevailing management attitude toward data communications and as such can affect the entire management structure.

Is data communications a service or a resource? The answer may vary from person to person and from organization to organization. In most, if not all, cases the individual answer is closely related to their attitude toward IRM in general. If the organization treats data processing and the information it produces as a service to support other functions, then they are most likely to see data communications as just another service. If, on the other hand, the organization has adopted the currently popular view of information as a corporate resource and asset then it is also more likely to treat data communications as something other than a service. Many organizations are developing an attitude that treats information as a resource and the organization's ability to produce, disseminate, and control information is considered an executive responsibility of some elevated status. Given this attitude it seems to be a logical extension that the ability to transfer information - data communications - must also be treated as a resource to be

planned, developed and managed within the organization's IRM structure.

Just as there is not an across the board acceptance of the IRM concept, the labeling of data communications is equally as diverse. Even in academic studies, as was noted by author Victor Fuchs, "Some studies include transportation, communications, and public utilities in the Service sector; others exclude these" [Ref. 29: p.14]. The difference, as to whether one labels data communications as a resource or service, may seem like a minor point to some. But it should be noted that many times the label something carries can have a definite effect on how it is treated.

By and large a service tends to be managed by a <u>reactive</u> management style and a resource or asset managed by a <u>proactive</u> management style. A reactive management style takes a more narrow view of the role of the entity that is the service. The service exists, waits to be called upon, and then <u>reacts</u> to that call to provide the amount of service requested. Certainly this is not to say that there is no management taking place in this environment. Costs are monitored, efforts to predict future demand may or may not be taking place, if the effort is being made the estimate is usually based on a review of historical data. Also, once called upon, the application of the service up to the level requested may be managed to some extent to try and ensure efficiency and effectiveness in regards to application techniques. Still the prevailing attitude is one of - <u>when</u> called upon, react. The private telephone system may be used to illustrate this point. The telephone company will install one or more telephones at a residence <u>after</u> a call is placed indicating that telephone service is desired. They are <u>reactive</u> to the call for service. While they may have estimates for a general demand pattern, they do not have estimates for a specific house. Nor do they just show up at your door

step to say, "Let us estimate for you how many telephones you really need to be efficient and cost effective, given your specific needs." They really do not concern themselves with the efficiency of a specific residential set-up (in regards to user needs), as long as they receive what they charge on a monthly usage basis.

Proactive management, on the other hand, carries with it the connotation of a different set of attitudes and management style. Under this style the manager treats the entity as a resource or asset to be applied aggressively as well as efficiently and effectively. The manager is fully aware of the organization's goals and objectives and sees the job as that of actively seeking out ways to use the resource in a manner that will facilitate the achievement of the organization's goals. The manager must seek out opportunities to utilize the resource, not sit back and wait for opportunity to come to his door. The manager must go to the user, work to understand the user's needs, help define real need as opposed to perceived need and view the user's needs in the context of the more broad organizational needs. Once that is accomplished the manager's expertise can then be used to best match current technology to user need.

The issue then of the defining of data communications as a resource or as a service is far from trivial as it determines how it will be managed and in the long term its usefulness to the organization. The answer to the question, "Is data communications a service or a resource?" is really to be found in the attitude of the organization toward information management in general. Since data communications is really the transfer or flow of information it seems reasonable that one can not really be separated from the other. As observed by consultant James Morgan,

> Telecommunications is generally melting into MIS/dp and office automation. Joining telecommunications and data

processing is no longer a bold step. It's the common thing to do. [Ref. 22: p.218]

Major corporations have also adopted this view in their planning for future direction. In his book dealing with the inner workings of IBM, author Rex Malik noted that back in the mid 1970's IBM products were, "....predicated on the notion that communications and computing are now inextricably intertwined" [Ref. 30: p.443].

The labeling of data communications as a resource or as a service is an issue to be settled by each organization. It must however, be addressed with full awareness of the current trends in technology, of the connotation connected with the respective labels, and of the relative importance within the organization of information management to the long term success of the organization.

B. IRM

The Information Resource Management (IRM) framework was discussed at some length in Chapter II of this thesis and this section will amount to supplementary remarks. IRM is defined in as many ways as there are authors who have written about the subject. It seems however, that one common denominator among the definitions is the idea that organizations need to take control and manage the entire information environment (under their control) as a whole. To do otherwise would seem to invite confusion, inefficiencies and lower overall effectiveness. The management focus is on the entire information system not just on its separate parts. In the authors' opinion that system is a means of collecting, recording, storing, processing and communicating information to satisfy the requirements and processes of all users. It seems that article after article and book after book stress the fact that the three key areas of data processing, office

automation and telecommunications are converging into one broader area of "information processing". A recent book by James Cash, Warren McFarlan and James McKenny stresses on several occasions this merging of technologies with statements such as, "Rather, the technologies of computing, telecommunications and office automation must be thought of as providing, in aggregate, a common cluster of policies and management focus" [Ref. 31: p.28]. The authors go on to express two of the major reasons why they believe these technologies must be managed as a single entity.

> The first is the enormous level of physical interconnections which increasingly must take place between the three technologies. The second major reason is that, today, execution of projects utilizing any one of these technologies poses very similar management problems. [Ref. 31: p.28]

The title "Information Resource Management" carries somewhat misleading connotations. An organization can not really manage "information". It can not manage it because information, in the purest sense, is not a physical entity. Information is a mental perception and its transmission is by electrical impulses. What can be managed however, are the people, equipment, document flow, electronic data flow routes and the management structure involved in the information process. Another very important issue then becomes the management structure associated with the elements, just mentioned, that constitute the information resource structure. Since this issue alone could provide an ample topic for further study, the focus here will be confined to the element of data communications and the new technologies of LAN, office automation, etc.

Should data communications be managed separately from data processing? As with all issues there does not exist a 100% consensus on the answer, but, the trend may very well

be as expressed by Cash, McFarlan, and McKenny, "Increasingly, the trend is to merge voice and data communications policy and operations in a single department, typically located within the DP department" [Ref. 31: p.77]. These authors follow this statement with what they believe to be an example of the benefit of such an organizational shift,

> For example, a large bank recently installed a system to manage voice and data traffic by controlling switches and line utilization. The system reduced their communications bill by 35%, with improved service to both the data processing effort and voice communications. [Ref. 31: p.77]

It seems clear that the answer to the issue of whether data communications and data processing should remain separated is tending toward the view of integrated technologies and integrated management of those technologies. This opinion has been expressed by many including the National Academy of Science, "A far greater potential exists for improving the overall management and command-decision process of the Navy through a fuller use of an information system, more broadly defined" [Ref. 23: p.15]. Cash, McFarlan, and McKenny also express this sentiment in addressing the area of planning,

> The planning process must be considerably broader in the range of technologies it covers than just data processing. It must deal with the technologies of electronic communicationss, data processing, office automation, stand-alone minis, and so forth, both separately and in an integrated fashion. [Ref. 31: p.232]

Much of this trend toward integrated management is being dictated by the increasing popularity of such technologies as office automation, networking, voice/data integrated circuits, etc. Office automation, for example, is no longer regarded as just a couple of word processors sitting on

desks. It is actually the coupling of word processors with communications and data base technologies, electronic mail, and others that really provide the potential for increased efficiency and effectiveness in the organization. Civilian industry has, by and large, moved in the direction of considering data communications and data processing as pieces of the same technological management pie. A recent survey noted that, "Three quarters of the nearly 1600 survey respondents said data communications responsibility rests with MIS/DP" [Ref. 32: p.28]. The issue of separating data communications from data processing may be one that is answered by the continued evolution of new technologies, but, at the present it is still one for today's management to review and decide upon. The insightful will do so with an eye toward the future.

C. INTRODUCTION OF NEW TECHNOLOGY

The introduction of new technology is an occurrence that every organization must face. The frequency of that occurrence varies from organization to organization, but, the introduction of new technology can not be avoided forever if the organization is to maintain any kind of acceptable level of efficiency and effectiveness. The issue at hand then is the "best" way of identifying, evaluating, incorporating, and operating new technologies within the framework of the organization. The managing of the introduction of new technologies is a complicated and time consuming affair that is fraught with potential problems in both technical and organizational areas. The proper management of such an evolution is of significant importance to the organization and worthy of higher management concern.

Several issues are contained in the paragraph above. These include:

1. Should an organization expend funds into R&D to develop new technology or should the organization be satisfied with utilizing advances made by others?
2. Who will be tasked to keep up with the emerging of advances?
3. Who will evaluate organizational needs in the areas affected by emerging technologies?
4. Who will match new technology capabilities to organizational needs?

The above is not an inclusive list, but should make it clear that this is not an area to be taken lightly.

The first question to be addressed deals with the decision to invent new technologies or to utilize those invented by others. Obviously to get into the inventing cycle will, in most cases, mean large investments in funds and for most user organizations this is just not feasible and not in line with their basic business goals. The more reasonable approach for most is to evaluate new technology as it emerges and to adapt only those that fit the needs of the organization.

Computers and data communications are rapidly advancing, technical fields. As pointed out by Cash, McFarlan, and McKenny, "There is no need for a firm to adopt leading-edge technology (indeed, many are ill-equipped to do so), but it is inexcusable <u>not to be aware</u> of what the possibilities are" [Ref. 31: p.12]. In fact William F. Synnott, author and Senior Vice President for Information Systems and Services Div, Bank of Boston, believes that, "keeping up with and using and controlling, such quantum leaps in technology represents the <u>major challenge</u> facing information systems managers in this decade" [Ref. 33: p.104]. Keeping up with technological advances is important and time consuming. In facing the problem the answer becomes a management/organizational issue. Nonetheless, the decision

must be made as to what organizational unit/function will be assigned that responsibility. Should each unit within the organization be responsible for keeping up with advances or should a more centralized approach be taken? As inferred from the previous quote, Synnott feels that meeting the challenge of evaluating the possible applications of advancing technologies falls within the realm of the information system manager's area of responsibility. Synnott describes what he feels are three aspects to meeting the challenge. These include: [Ref. 33: p.104]

1. Creation of "layered" architectures which will integrate all computer and information resource systems within each organization;
2. Connection of all elements of the layered information systems by means of a centrally designed and controlled corporate communications system;
3. Differentiating between corporate data bases and the various ones required by organizational units, while at the same time supporting transfers of information between the two types of data bases.

Cash, McFarlan, and McKenny also firmly place the responsibility for awareness and evaluation of new technologies in the hands of the Information Systems Manager and explain their reasons as,

> Appropriately staffed, an important part of its (Information System Management) mission is to scan leading-edge technologies and make sure that the organization is aware of their existence. It represents a critical mass, responsible for conveying knowledge of the existence of this technology, and of how to use it, to appropriate clusters of potential users. By virtue of its central location it can conceive where potential interconnection between the needs of different user groups exist and it can help to facilitate their connection. [Ref. 31: p.36]

The above are two opinions representing one side of the issue, others may feel that individual units within their

organizations have the expertise (and time) within each unit that is capable of keeping abreast of and evaluating new technologies. As is the case so often the answer may be organization dependent.

The last quote in the preceding paragraph leads into other connected issues - staffing, evaluating new technologies in terms of user's needs, and the evaluating of user's needs in the first place - that must be addressed in terms of where responsibility will be placed. Generally speaking new technologies are introduced into an organization with the idea that by doing so it will permit the organization to handle increased volumes of work or provide new or improved services or increase managerial effectiveness or possibly all three. The goal of managing this introduction of new technology is simply to enable the organization to better use current technology and to improve the integration of that technology into the organization. To keep abreast of and evaluate new technologies takes an investment - time. The new technologies must be examined as to what services they produce, who the potential users are, and what degree of success and satisfaction can be expected from the service.

It would seem that this evaluation could take place at one of two levels within the organization. The function could either be centralized or assigned as a responsibility of each organizational unit. The discussion now relates to that found in Chapter II, section D, if the responsibility is assigned to each unit to do, then there is a cost to the unit associated with that decision. As has been stressed, to keep up with and to evaluate emerging technologies takes an investment of time and expertise on the part of the organizational unit performing the function. In order to perform this new function each unit would either have to hire the expertise (at a cost) or draw from its present staff

(assuming the expertise required was already present in the unit) which detracts from the function which they were previously performing (cost of opportunities foregone). The possibility also exists that because of the unit's limited view of the organization its evaluation selections and implementations may be short range answers to narrowly defined problems. While in the immediate best interest of the unit concerned, the decision may not be in the long term best interest of the organization as a whole.

The second option then is to utilize a central pool of expertise which would be tasked with reviewing and evaluating new technologies and possible applications of these technologies within the organization. In an organization which utilizes IRM concepts the pool, placed within the IRM division, would be at a level in the organization which allowed them to be aware of the strategic goals of the organization and evaluate new technologies accordingly. The team of experts must be able to understand the goals and then evaluate new technologies in the context of their potential contribution to reaching objectives that will make the organization's long term goals achieveable. As emphasized in the quote from Cash, McFarlan, and McKenny (printed earlier in this section) the key is "appropriately staffed" and to add staff incurs a cost. The question would then be how best to maximize the return for the cost incurred. To staff such a function centrally, as opposed to staffing each individual unit, would seem to provide some economy of scale. Also, if a central pool (due to time available to apply to the task, or a higher level of expertise, or through benefits derived from shared knowledge, etc.) can provide better decisions on choosing and integrating new technologies then the cost of additional staffing may be offset by organization-wide benefits derived from those decisions. It may be worth remembering that in the area of

choosing and applying new technologies, excessive conservatism can result in missed benefits and unrealized cost reductions. On the other hand, uninformed or premature attempts to utilize new technologies can result in rather expensive disasters. The question or issue to be decided is at what level in the organization to place that responsibility so as to best avoid the above extreme consequences.

Of course, a third option is to allow units to individually contract out for outside consulting and industry representatives to come in and identify user needs and the appropriate technologies to meet those needs. The advantages, from the user's viewpoint, may be a sense of control in that the unit can pick the who and the when of the consulting service. The unit may also feel that the recommendations will be more tailored to its specific needs since the outside consulting service will be concerned with only that units needs and not with any broader view of the entire organization.

The broader view of this issue addresses the concern that the unit's judgement may become based on perceived needs vice real needs. Thus they may be influenced into believing that what the industry happens to want to sell is what they need. The costly result being that the unit ends up with what exactly what it asked for - not what it needed. Also, lost is the opportunity to build a corporate knowledge of problems matched with solutions that could be transferred or utilized from one unit to the next. This theme was voiced by Edwin Odisho, a senior system analyst at NASA's John F. Kennedy Space Center, when suggesting the advantages of borrowing on the experience of others, "If I have one piece of advice, it's to find someone else who has had the same kind of problems you have, but is a little bit ahead of where you are" [Ref. 34: p.84]. Put in different terms, the danger of individual units inventing the wheel is not only

the wasted cost of reinventing the same wheel, but also the possibility that they will all come up with the same <u>square</u> wheel.

D. TECHNOLOGY TEAM

1. Internal vs. External

Among the issues discussed in the previous section was the one concerning the staffing of individual units within the organization with sufficient technology expertise to keep up with and evaluate new technologies versus staffing in a more centralized manner to perform that function. For the purpose of the discussion to follow the expertise pool will be referred to as the "technology team". Also briefly mentioned was the the option of using contracted consultants to perform this same function. These issues will be discussed in still further detail in this section.

The first question to be considered is why any organization or unit within an organization would go outside of its internal resources and make use of external sources. The reasons can of course vary, but author Harry I. Greenfield provides, as one possible set of factors that influence an organization in such a decision, the following: [Ref. 35: pp.37-39]

1. The desire to produce (a product or service) at a lower cost through contracting out, due to economies of scale;
2. Desire to increase quantity of output by making use of a contractor firm's (or any organization outside the boundaries of the unit level in question) personnel, which are needed on a full time basis, rather than than by expanding the basic producing organization; and

3. Need to tap the expertise of specialist who can keep the firm abreast of technology, assist in updating, minimize risk and provide guidance in respect to the firm's growth.

If the decision is made to perform the function at the individual basis, but without adding to the staffing level of the units, then the process of deciding what to give up must take place. The reader is referred to Chapter II, section D, for a detailed description of what is involved in such a process. If the decision is made to centralize the function and utilize a technology team at a more corporate level, then another possible issue arises. The issue can be phrased as, "Should the user unit be required to use the parent organization's team or should it be allowed to choose between that team or consultants from outside the organization?"

For the parent organization to provide an additional service involves a cost to the organization. That cost can either be absorbed, in an accounting sense, as overhead or charged on an as used basis to those units of the organization that use the service. Costing schemes and algorithms can be very complicated and possibly unique to the particular organization and service in question and is not the focus of this discussion. In general however, if a charge system is to be used the organization will want to at least recover the cost of providing the additional service. A detailed discussion of this, as it relates to the IRM framework, can be found in Chapter II, section C. One side of the issue raised here is that if the potential user of the service is allowed the freedom of choosing between the organization's Technology Team or a similar service available outside the organization and if the user knows the cost to be charged by each, the user can (as discussed in Chapter II, section D) make the decision based on least cost for

similar services. The result will be good for the user in that there is a cost savings for the unit and may or may not be advantageous to the organization as a whole.

On the other hand, if the user is required to use the organization's Technology Team, the cost to the user may or may not be greater but the organization as a whole may derive greater benefit. The reasons being that by requiring units to use the organization's Technology Team the opportunity for growth in the expertise and corporate knowledge is increased with the result that it may add to the effectiveness and efficiency of the team. Also the advantage of technology transfer across the organization, of solutions more attuned to organizational needs and in concert with the organization's long term goals and strategies can be attained. The caution here however, is that the fact that the user is limited to using only the organization's team's service takes away the incentive for efficiency that usually is present in a competitive situation, such as the one described in the previous paragraph. Therefore, the organization must substitute other measures that will ensure the need for efficiency is not lost.

2. The Organization Technology Team

If an Organization Technology Team is to be formed it must be done with a goal of providing quality service, and the right service, at a minimal price. Ian Angus has suggested considerations for users to be aware of when reviewing proposals provided by telecommunications consultants that could act as well as a check list for a Technology Team to evaluate its own standards. Angus mentions the following areas of considerations: [Ref. 36: p.69]

1. Consultants understanding of the users requirements.
2. Technical experience level of consultant.

3. Pragmatic approach - does the consultant apply appropriate technology to the problems or does he attempt to force the client to fit into preconceived patterns.
4. Ethics.
5. Managment experience.
6. Concern for detail.
7. Current knowledge of technology.
8. Relative consulting staff size.

The question of the size and make-up of such a team is also a valid one and the answer is closely tied to the organization itself. Related questions also include, "Is the team to function in a reactive or proactive style (as defined in section A of this chapter)?" and "What is the scope of potential clients?" If the team is reactive then, at least initially, the demand may not be of any great level and a large staff would be underutilized. If the scope of potential clients is to be held small then both the demand would be expected to be lessened and the potential technological applications could be narrowed and expertise in fewer fields would be required to be staffed. On the other hand, the team and the service they are to provide is to be treated as a resource. Then, if it is to be applied organization-wide and in a manner that maximizes the potential effectiveness and efficiencies offered by new technologies, a proactive style is more likely and a broader foundation of technological expertise is required. The team may actively seek to identify data communications problems rather than wait for users, who may or may not be in a position to even recognize the scope of the problems or of the potential value to be gained from technologies that are properly applied.

Lastly, organizational change, whether to accommodate the forming of a new functional unit like a

Technological Team or redefining organizational responsibilities in acknowledgement of technological trends (ie. merging of the telecommunications, data communications, and data processing fields) always faces some resistance and is never to be done without due consideration. One may however, wish to consider the following points made about a successful giant in the computer field, "As the market changes, so IBM will change the organization as well as the lines of responsibility and communications" [Ref. 30: p.257]. Also,

> If there is a trick to IBM, it lies in its belief in structure and its ability, almost reflex, to allot one man or however many men are required to look after any task at hand and do so quickly once management has so decided. [Ref. 30: p.273]

It should be remembered that to change for the sake of change is wasteful, but to change in recognition of the present as it stands and in preparation of the future as it is perceived is management's duty.

VII. ANALYSIS AND RECOMMENDATIONS

A. INTRODUCTION

A frequently articulated justification for studying history is that it repeats itself and lessons can be learned to preclude previous disasters, fiascoes, and mistakes. This idea seems to have equal validity and application in the ADP/data communications arena. For this reason, the underlying theme of the authors' analysis is focused on the past and the lessons that can be derived from it. In contrast, the recommendations are presented with a view towards preventing the recurrence of similar mistakes in the future.

B. ANALYSIS

The question of whether data communications is a service or a resource seems to be fundamental to whether or not IRM philosophy is to be adopted by an organization for managing data communications. The answer will have profound impact on the management actions and perceptions. If data communication is treated as a service, an examination of history suggests that a reactive management style, as noted in chapter VI, will prevail. The implication of this style is that of a "big bang" approach. In other words, a "wait and see" attitude is dominant and this often leads to the reasoning that all can be made better in one fell swoop by means of a single plan; a panacea. This cannot possibly work in the ADP environment as demonstrated by past failures. Clearly, the lessons learned from the short life span of ADP could not have been forgotten. The concept of evolutionary development in the ADP environment should now have a strong foothold in the minds of system managers. Evolutionary

development is associated with a proactive management philosophy. What this entails is a framework for growth. Specifically, what is needed, as James Martin states, is

> .... not an all-embracing, grandiose plan but a framework which will permit step-by-step growth, each step suitably small. The separate steps should fit into an overall framework so as to have whatever degree of capability and interconnectability is beneficial to the corporation as a whole, now and in the future. [Ref. 11]

In essence, flexible planning and in particular strategic planning is paramount. With consideration towards preventing recurrence of past mistakes, data communications must be treated as a resource, in the authors' view. By doing so, IRM philosophy can provide the framework for data communications management.

As stated in an earlier chapter, "information" cannot be managed in the sense that it is not a physical object or thing. Rather, information resource management entails the management of the people, equipment, facilities, procedures, structure, and other related objects involved in the flow or process of providing information. From Chapter II it was learned that basic incentives, rewards, and penalties are essential for managing the various system components by Central Management. Unfortunately, within the Navy, direction (incentives, rewards, and penalties) for data communications originates from an entirely different source than that which provides direction for information systems. It was previously noted that COMNAVTELCOM will soon have overall responsibility for all communications (both data and voice) while COMNAVDAC provides central management for ADP matters. Organizationally both report to the same OPNAV code. Operationally, each has its own separate management styles, influences, and requirements. In contrast, private organizations have more closely aligned data communications

and ADP by merging policy and operation aspects of the two in a single organizational entity, typically within the DP section. This is further supported by industry surveys (Chapter VI, Section E) which note that the majority of ADP data communications managers believe data communications responsibility rests with the DP community. For example, at W. R. Grace, a diversified $6.2 billion multinational firm that operates in 47 states and 43 foreign countries and one of the world's largest companies, there is one director for both voice and data communications - Robert Norian. Within the company there are a heterogeneous collection of networks, "pockets" of networks, that serve the company's largely autonomous divisions. On the question of the problems he faced with a stronger data background than voice, Norian stated:

> It was a plus because as the technology of switching systems moved from electromechanical design toward computer driven design, it was a natural evolutionary step. Therefore, the jargon, the understanding of how these things worked was a natural step. It was a comfortable transition.
>
> I suspect that the reverse would probably be a little more difficult for people, and I have seen that. It is a little more difficult for traditional voice people to move into the data sphere. [Ref. 37]

In keeping with the authors' theme, history seems to favor DP leadership as the most logical choice for managing data communications. As noted at W.R. Grace, the trends in private industry support this because the DP staff was forced to learn about telecommunications before telecommunications personnel became involved in DP. Additionally, the DP community has been exposed to life cycle management requirements with the attendant capital investments. Finally, if a classification of DP managers in the aggregate can be made, it is the authors' opinion that they would be closer to proactive than the classification of

telecommunications managers. In all fairness to NAVTELCOM, corporations in industry generally do not have structures comparable to the Navy's. In other words, separate telecommunications managers within corporate organizations do not exist. Therefore, ADP staffs were forced to accept data communications responsibilities. Consequently, the Navy's situation is unique. Still, lessons learned can be applied in a general sense. More specific, the new NAVTELCOM organization which will be effective 1 October 1984 seems to lend itself to the kind of structure needed to manage data communications as does the current NAVDAC organization. Noticeably absent from the NAVTELCOM organization, however, is the provision for data communications specialists at each of the regional divisions. This is imperative if NAVTELCOM is to become the Central Manager of data communications.

Inasmuch as COMNAVTELCOM and COMNAVDAC are, in a sense, type commanders of their respective services, each would seem to have valid reasons to assume overall management of data communications services within the Navy. With both organizations reporting to the same OPNAV code, it would seem more appropriate to implement a steering committee or information systems board comprising members of both organizations. The resolution of any problems can be accomplished at the OP-94 level. In this way, a more coordinated effort could be applied to the assessment of costs and benefits associated with decisions on the entire spectrum of information resource management (including data communications).

Whether NAVDAC or NAVTELCOM should be the Central Manager of data communications cannot be resolved at the authors' level. Irrespective, something must be done to ensure that management does not lag the rapidly changing technology. One way is to develop a workable strategy that can be applied independent of the technology. As the arteries of informations systems, data communications affect

virtually every component in the system and therefore virtually every decision regarding its management. Long range planning in this area, therefore, must consider various dimensions. These dimensions are basically: the setting of standards, the selection of architectures, the selection of hardware/software, usage decisions, the design of the data, and application development. Moreover, these dimensions must be considered from the aspect of control, i.e., centralization, decentralization, mixture of centralization and decentralization, or strong cooperation between central management and the decentralized components.

Without any reservations, standards must be set at a highly centralized level to ensure uniformity throughout the organization. In addition, the selection of computer network architecture must be strongly centralized to ensure future compatibility and growth. Both data design and hardware/software selection requires close working relations between central management and the decentralized users. Usage decisions and application development are dimensions which can be a mixture of centralization and decentralization. In other words, some usage decisions or applications development can flow from the top down while others can be initiated at the local level. [Ref. 11]

Armed with this overall strategy, the question of how to deal with rapidly changing technology remains. In view of the relative immaturity of network technology yet the increasing acceptance of its utility, Central Management's problems remain formidable. Because computer network technology is relatively immature, new innovations and implementations are constantly occurring. As wide spread acceptance is achieved, concerns for the proliferation of incompatible systems arise, particularly in view of longer range projections for the need to have inter-network capabilities. The introduction of new technology and the issues associated

with it were discussed in detail in Chapter VI, Section C. Fundamentally, the key issues referred to the determination of organizational (user) needs and whether the evaluation process to make this determination should be done internally or externally and whether or not a central group should be employed for this function.

From the outset, the object of the research was to find out what role NAVDAC should play in providing technical advice/support to its Navy customers. Perhaps this focus was too narrow and a broader perspective should have been adopted. More realistically, the question can be rephrased to "Who in the Navy should provide technical advice/support to its data communications users?" It seems evident from the arguments presented that a real need exists for this service. Further, whoever becomes the appropriate instrument for effecting telecommunications in support of ADP applications, complete cradle to grave support must be provided in a competitive fashion. By this, the authors mean that the users should be free to select services from competing sources (consultants, etc.) but with consideration to life cycle aspects. The principal question of how the Navy should serve its data communications customers remain. There are probably many ways including the establishment of the previously mentioned steering committee (similar to a corporate IS board), and the implementation of survey teams. The authors submit, however, that whichever way is chosen all must first focus on sizing the problem. For this reason, the following recommendations for a Technology Team as discussed in Chapter VI seem appropriate. The composition of the team is deliberately omitted since it is a subject which requires even further study and it is within the prerogative of Central Management (NAVDAC, NAVTELCOM, or the steering committee).

C. RECOMMENDATIONS

In order for individual units to approach any acceptable level of effectiveness in applying new technologies to present and anticipated data communications problems, they must gain current and reliable information and direction. As a result, the units must obtain information from vendors/ consultants or from expanding their individual staffs with experts in the various emerging technologies. As discussed in an earlier chapter, vendors can be inconsistent in their applications and not concerned with broader organizational concerns. Expanded staffs tend to be expensive, underutilized and, when taken from the broader top down organizational view, redundant.

An executive level Technology Team (NAVDAC level) or perhaps Technology Teams distributed at the regional sites (slightly decentralized at the NARDACs or at NAVTELCOM regional divisions) offers many advantages considering the relative immaturity of network technology, the rate of change of ADP technology, and the current state of the Navy in relation to state of the art technology. A Technology Team at the NAVDAC/NAVTELCOM level could allow for focusing on the strategic relevance of user's request for data communications services. The team could be responsible for planning and the organizational direction of data communications by formulating the previously mentioned overall strategy for data communications. This would also imply that the team must be apprised of the Navy's organizational goals and objectives. The team could be used to provide the centralized control for setting standards and for the selection of network architecture. With regard to data design and hardware/software selection, the team could provide the strong coordination with users to ensure overall consistency and compatibility. Any usage decisions or applications

development emanating from the upper echelons (Central Management) could be provided by this team.

Consistent with the theme of retaining flexibility in strategic planning, i.e., it should not be a single grandiose plan, the Technology Team would proceed in small incremental steps. First and foremost (after formation) could be to size the data communications problem. This could be accomplished for common or general problems existing throughout the user community. Focus could then turn to individual units within the organization for more specific problems from the top down. These data communication surveys could form the baseline for developing the overall strategic plans which again would be subject to continuous change and adjustment.

A basic tenet of design is that it is driven by organizational needs. Whether or not a user component of the organization elects to use the Technology Team, the organizational needs must not be discarded. Frequently, the overall organization's needs are unimportant or unknown to a unit component at a low level. The Technology Team could be employed to ensure that requests are aligned with the overall organization's needs. In the event a consultant is used by a user component instead of the team to develop its data communications requirements, the team could be used to review the vendor's analysis or proposal. This review would be performed to ensure consistency and compatibility, to match technology with need, and to ensure relevance to the overall organization's needs. A Technology Team under the auspices of the steering committee seems to be the most logical and ideal implementation for providing the needed data communications services to users. Therefore, the authors strongly recommend that this approach be taken. The recurring question of who should be responsible for data communications services again arises but in a different

form. The question now becomes one of where the team should be located organizationally. Should the team be under NAVDAC? NAVTELCOM? The steering committee? Moreover, the more practical question of how the team should be funded arises. The following paragraphs provide a solution to this problem and uses the NAVDAC organization for implementation. The same approach could be applied to the NAVTELCOM organization or to the steering committee as appropriate.

The competitive environment of ADP services caused by the introduction of NIF funding makes the implementation of a Technology Team more difficult Within the NAVDAC organization. To deal with this, the authors' recommend that the team be mission funded for a specified period of time, for example, two years after formation. Users would be free to utilize consultants or the organization's Technology Team. In all likelihood, the users would take advantage of the "free" service. This would benefit not only the user but also the Technology Team. As noted previously, it is important to build the corporate knowledge (history) and the technology base. An introductory period would provide the opprtunity for developing these two essential ingredients. Additionally, an opportunity for establishing a good reputation for the team would be provided. Therefore, it would be imperative that the team be staffed with professionals, knowledgeable and able to deliver useful results. After the period of mission funding, the Technology Team could be made available on the "open market". In other words, the team could be contracted out on a reimbursable basis for services as required. This, of course, implies that by this time the team must have refined its operations to the point that it can provide a price competitive, quality service. There are many potential benefits of the Technology Team concept. The purpose here was to provide a skeletal introduction to stimulate thought on how to improve data communications services

within the Navy. This concept or something similar needs to be pursued in order to fill a need that was so clearly articulated by the National Academy of Sciences regarding the application of new technology to improve organizational performance. The findings report:

> Units at various levels within the Navy appear to have no place to turn to receive good advice on how their information systems might best be developed technically or to receive appropriate guidance in making the task changes that information systems require. The committee believes that providing leadership, assistance, and guidance in systems are functions that ought to be readily available to almost every organizational unit with the Navy.

VIII. SUMMARY AND CONCLUSIONS

A. SUMMARY

Throughout this study, the authors sought to establish a framework from which logical conclusions could be drawn and meaningful recommendations could be made regarding the role NAVDAC should play in the area of data communications. By employing Information Resource Management philosophy founded on economic considerations, it was hoped that conclusions would leave little room for argument. The IRM system was deliberately described at a low level in order to facilitate reader understanding and so as to permit application at a much higher level by abstraction. The high level in this case, of course, would be Navy-wide or possibly DOD-wide.

By equating Central Management to the OPNAV level, OPNAV's role as the overall system manager and coordinator of the organization's activities becomes more evident. Similar equivalency is apparent when matching other organizational components of the Navy with those described in the IRM system (see 2.1). In this same vein, the concepts and processes of decentralized planning, coordination, and control within the IRM system seem to be directly applicable to the Navy's organization. With respect to the decision-making behavior of each of the IRM system components in regard to such issues as capacity, technology, and product mix, great similarity also exists when a comparison is made between the IRM system and the Navy's structure. Although the IRM decisionmaking process was illustrated by seeking the solution to the capacity choice problem alone, the process itself was the important aspect. The process is equally as applicable to other decision problems including

the technology choice problem and the product mix problem. These decision problems are fundamentally no different than those which exist at all levels within the Navy. Therefore the IRM process for seeking their solutions would be appropriate for Navy use. Finally, without some form of structure to the organization and the associated incentives, rewards, and penalties, the IRM system could not operate effectively. Within the Navy there are commensurate forms of incentives, rewards, and penalties as well as the needed structure.

From a user standpoint, the IRM system focused on aspects of costs and benefits given that Central Management provided a given budget. Users within an IRM system would balance costs (including opportunities forgone) with benefits including intangible ones. The kinds of considerations when confronted with the option to acquire a new service was presented with various alternatives to arrive at a satisfactory decision. Aspects of in-house versus buying in the competitive market were discussed. In short, a brief outline of the kinds of considerations which users must take into account were provided. Clearly, these considerations are equally as applicable from the Navy's perspective.

To establish that NAVDAC and its satellite agencies are indeed confronted with the kinds of considerations present in an IRM system, a brief overview of the NIF system within NARDAC was provided. With the transition to NIF funding, NAVDAC's clients, the users, also become more involved in the IRM kinds of considerations. Unfortunately, the buyer-seller relationship between NAVDAC and its customers is more complex than that which exists in a typical private sector enterprise. As noted previously, one of the biggest differences results from the NIF imposed requirements for stabilized rates. Stabilized rates provide for a measure of predictability from the user's stand point. However, the true costs for the services may not be evident since the

charges are based on recoupment of previous years' gains or losses. Although the situation may facilitate budgeting at the user level, it conceals the actual costs and makes the decisionmaking process for customer managers difficult. In other words, customer managers must use the stabilized charges for comparison purposes with the price of competing services. Alternatively, a two or three year horizon must be adopted in developing the actual costs to compare with market prices. The administrative burden of adopting the latter approach may be costlier than the benefit value to be derived from it. Although it may be simpler to use the stabilized rate charges for the economic considerations, it also carries with it other implications. In any given year, the stabilized charges will most likely be less than or greater than the prices from competing sources. Depending on the year in which the service is acquired (most likely when the charges are less than competitors), the following year's charges could very possibly be higher than competitor's. This poses a unique challenge to customer managers.

The vehicle for recoupment of the operating costs at each of the NARDACs is the chargeback system. Typically, chargeback systems suffer from many unsatisfactory consequences including complexity in the calculation of the charges which user management may find difficult to interpret. The NARDAC chargeback scheme seems to manifest similar shortcomings. However, this is mitigated to an extent by the stabilized rates.

In order to provide better foundation for discussion, the next chapter focused primarily on the details of linking computers. First of all, the reasons for linking computers was presented. Basically, the reasons revolve around harnessing data, processing power, applications, or any computer resource in order to make the resource conveniently available to users in a completely transparent manner. Other

reasons include tc increase system reliability, to distribute processing power in a logical way, and to provide economy and flexibility.

Closely related tc the reasons for linking computers are the uses. These uses fall essentially under three principal categories. The first category of computer network use concerns access to processing power. The second involves access tc data and the final category relates to employing computer networks as a communications medium.

To illustrate the relative immaturity of computer networks, scme of the ways to link computers were discussed. Three different methods for linking computer hardware (including peripherals) in a local network prevail and are associated with different vendors. They are collision avoidance and detection, token passing, and star. In the long haul arena, a description of the method of connection used in the DDN was described since it is the principal vehicle for meeting DOD data communications needs.

From the overview of the reasons for, the uses of, and the ways to link computers, the reader should have gained a "feel" for the kinds of problems which information systems managers at all levels must address. In a very general way, these prcblems fall under the headings of control, function, and location. More specific, some of the problems include:

1. different vendcrs have different line control procedures which make interconnection of different machines by telecommunications very difficult;
2. incompatibility in the different network architectures;
3. software inccmpatibilities exist with different vendors;
4. data base management systems are incompatibile; and
5. internetting is difficult.

With the foundations established, the next chapter provided an expanded discussion of ADP and data communications. First of all, the marriage of the two technologies was presented as inevitable. The reasons (discussed in chapter IV) for networks have become more justifiable, largely because of the increasingly favorable price/performance ratio of hardware and user perceptions of greater efficiency and effectiveness. Although evidence (expert opinion) was presented in support of wide spread acceptance of network technology, the authors' have reservations about the maturity of the technology. These reservations stem from the management issues outlined at the end of the preceding paragraph. Irrespective of these, the key point is that networking is becoming more important to organizational entities of all sizes and is rapidly gaining increased acceptance. It is getting bigger and bigger and projections support continued growth.

To remove all doubt that data communications is a management concern, aspects of costs were discussed in the next section. With the understanding that data communications is not a "free good," the question becomes one of determining just how much is expended on this resource. This is an extremely difficult question to answer, particularly with the union of telecommunications and data communications. The problem of ferreting out data communications from telecommunications was illustrated by the FCC's decision to abandon its efforts to classify various services and equipment as either data or voice communications. The trend in corporations has been to consolidate the two. This again raises the question of who should be responsible for the overall management of the two.

Within the the Navy, all communications support (whether data communications or telecommunications) will fall under the purview of a single organization, NAVTELCOM, as of

October 1, 1984. To acquire support, in the area of data communications, different procedures exist depending on whether the request is for long haul data communications or local. In the long haul area, use of the DDN was mandated by SECNAV in order to achieve the advantages of having a national data network. DDN system waivers are approved only if the requester can prove that the DDN cannot meet the user's requirement. The TSR is the vehicle for acquiring communications support.

The next chapter focused on key management issues leading to the analysis and recommendations portion of this thesis. Basically, the issues revolve around organizational needs and how to keep pace with the continuously changing technology. The ideal vehicle for dealing with new technology seems to be the use of a Technology Team in concert with an information systems steering committee or board. Within the Navy this steering commitee should be above the NARDAC/NAVDAC level in order to ensure that the overall organizational needs are met. The Technology Team can be placed organizationally under the steering committee, under the NAVDAC banner, or under the NAVTELCOM organization. Irrespective of where the team is located organizationally, there is a real need for its implementation. This, in short, is the essential element needed for both ADP and data communication managers to meet the challenges of the future.

B. CONCLUSIONS

In conclusion, the future holds many challenges for ADP/data communications managers. The key to success will be the lessons learned from the past and the ability of these managers to use these lessons to better plan ahead yet remain flexible in the face of rapid changes in technology. NAVDAC, as the ADP expert, and NAVTELCOM, as the communications expert, must provide this needed leadership.

APPENDIX A

LIST OF ACRONYMS

1. ADP - Automatic Data Processing.
2. ADPE - Automatic Data Processing Equipment.
3. ADS - Automated Data System.
4. AIS - Automated Information System
5. AT&T - American Telephone and Telegraph.
6. AUTODIN - Automatic Digital Network of the Defense Communications System (DCS) for record communications.
7. CNO - Chief of Naval Operations.
8. COMNAVDAC - Commander, Naval Data Automation Command.
9. COMNAVFACENGCOM - Commander, Naval Facilities Engineering Command.
10. COMNAVTELCOM - Commander, Naval Telecommunications Command.
11. DCA - Defense Communications Agency.
12. DCS - Defense Communications System.
13. DOD - Department of Defense.
14. DON - Department of the Navy.
15. DP - Data Processing
16. GAO - Government Accounting Office
17. LCM - Life Cycle Management.
18. MPP - Marginal Physical Productivity
19. NACDAC - Naval Data Automation Command.
20. NALDA - Naval Aviation Logistics Data Analysis System
21. NCS - National Communications System.
22. NIF - Navy Industrial Fund
23. O&M - Operations and Maintenance.
24. OMB - Office of Management and Budget.
25. OPNAV - Naval Operations

26. RMS - Resource Management System
27. SECDEF - Secretary of Defense.
28. SECNAV - Secretary of the Navy.
29. TPC - Total Productivity Curve
30. TSR - Telecommunications Service Request.

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